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ATTACHMENT A
TABLES

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Table 1. Plants and buildings used at the St. Louis Downtown Site for MED/AEC uranium processing work.

Plant	Building	Process, function, or area	Notes
1	25	Lab quality control, R&D	Project offices
1	Alley south of 25	Pitchblende R&D extraction	
1	K1E	Temporary pitchblende ore pilot plant	For MED/AEC work, used only from 1944-1946
1	A	General plant maintenance (for all of Mallinckrodt)	
1	P	Engineering Department (for all of Mallinckrodt)	
1	X	Locker room	
1	Z	Company headquarters; administrative offices	Administrative headquarters for MED work until Plant 6 began operating in 1946
2	38B	Personnel change house	FUSRAP (2003a) says 38B, but ORAU (Mason 1977) says 38A
2	40	Temporary storage of residues	Temporary storage of residues
2	45, 45A	Warehouse	Raw, in-process, and finished materials
2	47	Warehouse	Raw, in-process, and finished materials
2	50	Feed material and product storage, UF_4 experiments, mechanical repairs, tank storage, other	Ore concentrates, UO_3 product; tanks of stored process liquids; UF_4 experiments performed in the "sulfur burner room"
2	51	U_3O_8 feed preparation (nitric acid dissolution), recovery, other	
2	51A	Denitration of UNH to UO_3, reduction of UO_3 to UO_2	
2	51X	Temporary canopy enclosure outside for extraction of pitchblende liquor	
2	52	Ether extraction to produce uranyl nitrate hexahydrate (UNH)	
2	52A	Miscellaneous(?) re-extraction	Pilot plant for countercurrent ether extraction
2	52X	Canopy, temporary structure	
2	55	Shotgun lab -- temporary structure	This was a special restricted area because of the 100-mg RaBe source used in the neutron absorption testing
4	400	Production of UF_4, U metal; slag handling, production control laboratory, changehouse; metals pilot plant	UF_4 product, U recast
4	400, 401	1st floor: casting pilot plant, slag pilot plant, dingot works	In casting pilot plant: lead man office and saw room; in slag pilot plant, roll mill, chip burning area, and Hoffman cleanup area; in dingot works, blender, saw area, bomb air cooler, bomb cooling room, breakout grate, furnace tank pit, and furnace residue pit
4	400	2nd floor: bomb step area; casting area, laboratory area, ceramic pilot plant	In bomb step area: blending and bomb areas, KB-2 area, bomb tramrail
4	401, 401A	Maintenance, metal storage, and UF_4 pilot plant	
4	402	Warehouse center	
4	403	Machine shop	
4	404	Storage room	
4	405	Part of the lathe and forging area in 408?	
4	406 (A&B)	Magnesium storage	
4	407?	?	
4	408	1st floor: lathe & forging areas; storage of slag, dolomite, KOH, NH3, HF, etc.	Pilot Lab; furnace; forge press; manipulator; lathe area; slag crushing area; salt bath and quench tanks; slag storage
4	400 Yards	Machine shop (403) yard; guard house and guard tower; incinerator	There were also various production dust collectors in these yards outside 406B and 407
6	100	Electrical substation	Shed attached to the west end of the building was used for storage of uranium materials.
6	101	Research laboratory, decontamination(?) room, receiving offices	Also production offices, shipping & receiving, and decontamination (DX) facilities. Lab had hoods, the DX facility a hood.
6	102	Analytical Laboratory (main chemical lab), Control Lab, Metal Lab, Sample Prep Lab; possibly an additional R&D lab; lab offices	The Control Lab had a hood. There was a dust collector on the roof.
6	103	Refrigeration (air conditioning), spectrographic laboratory	
6	104	Main refinery building: ore to UO_3 to UO_2	Entire building housed wet processes. Barium sulfate cake, raffinate cake were residue products
6	104	Ore Room digest area, feed makeup area, M-20 area, C-3 area	Found to be the most contaminated areas in 1958 due to use when pitchblende was main feed; beta, gamma especially high in Ore Room and M-20 areas (latter up to 12 mr/hr)
6	104	Raffinate area, wet pilot plant, ether pilot plant, pot room, pot room addition, QM-2 packaging, NA recovery area, MGX area	Housed the continuous process equipment
6	104A, AA	Main refinery: ore handling and milling	Pitchblende ore (104A)
6	104B	Main refinery: pilot plant area	Pitchblende
6	105	Main refinery: the " Ether House"	Extraction
6	106	Nitric acid recovery	
6	106A	Nitric acid recovery	
6	107	Nitric acid recovery, tank farm pump house	

Table 1 (Continued)

Plant	Building	Process, function, or area	Notes
6	108	Shotgun sample preparation lab	Superseded by lab in Building 102? ["Old shotgun lab"]
6	109	Acid unloading station	Includes 109, 109A, 109B
6	110	Main warehouse for bagged goods, storage of pitchblende ore and ore concentrates, UO_3 product	Pitchblende ore, ore concentrate, UO_3 and UO_2 product. Was the receiving warehouse for pitchblende ore arriving by rail. Found to be moderately and uniformly contaminated (including gamma) in 1958 due to trackage, especially on loading platforms.
6	110A	Main warehouse, part used as Ledoux Lab	
6	110B	Automotive repair	
6	111	Sample preparation and LeDoux Lab, north end; maintenance shops in the south end	The Ledoux Lab included the main lab room, the oven room, the weighing room, and the dry box room; in these areas were a muffle furnace and dry boxes. It was found to be contaminated in 1958; the main(?) room had a walk-in hood behind which the floor was heavily contaminated.
6	112	Administration (MCW and AEC offices), Health Laboratory, dispensary; maintenance shop, instrument shop, maintenance stores	This building was 50% offices, uncontaminated, and 50% storeroom and shops, both handling some contaminated materials.
6	113	Paint shed	
6	114	Scale house, temporary storage of residues	For temporary storage of residues, including radium-bearing cake (K-65) in drums. Had interior sampling bays and an exterior conveyor. Found to be heavily contaminated in 1958, including some gamma.
6	115	Boiler house and steam plant	
6	119	Steam plant, maintenance storage shed	
6	120 & 121	U metal dissolver (120) with digest and recovery area (pitchblende); pickling building (121)	120 had a sump; 121 had a derby conveyor and pickler. Found to be heavily contaminated in 1958.
6	122	Slag recovery pilot plant	Found to have loose contamination
6	123	Ammonia & dissociator	Ammonia cracking?
6	101 Yard	Loading docks	Used by Shipping & Receiving.
6	104 Yard		Found to be contaminated in 1958. Gamma background from M-20 cell block.
6	105 Yard	Outdoor tanks	Concrete, asphalt, gravel all found to be contaminated in 1958. Tanks, sump in the M-70 pit. Hole by 105 door due to cave-in caused by sump leakage.
6	106 Yard		Found to be contaminated in 1958.
6	NW Yard	Storage yard	Found to be contaminated in 1958, including some high gamma spots.
6	108 Yard	Laboratory site	A laboratory on this site was demolished in 1955, except for the concrete floor. Materials handled contained radium.
6	110 Yard	Boxcar cleaning site	Boxcars that contained pitchblende ore containers were cleaned on the gravel-soil part of this yard; there was a 1.5 mR/hr hot spot between the rails and a 5 mR/hr hot spot under the shipping dock in 1958. A sewer ran under or over the yard.
6	111 Yard		Found to be contaminated in 1958. A sewer ran through the yard.
6	112 Yard	Concrete between 112 and 117	The main gate opened into this yard, as did the dispensary doors and a change room. Some contamination due to trackage
6	115 Yard	Concrete adjacent to the boiler house	Dust collector and incinerator created heavy contamination in yard. An ash silo and the Hoffman drumming station were located here.
6	116 Yard	Storage area	Storage of feed materials. Some contamination, including gamma.
6E	116 (including 116-1 and 116-2)	UF_4-to-metal facility (116-1?) with various operating areas and a maintenance shop, residue recovery area, warehouses (116-1 and 116-2), graphite machining, foremen's office (116-2), smoking area	Used for manufacturing UF_4 to metal: reduction furnace area (~ 18 furnaces); casting furnace area (with multiple furnaces, 4 hacksaws, Kinney pumps, a crushing station, toilet area); breakout area (with sump, slag conveyor, chipping station, furnace rebuilding station, shop); jolter area (with jolter platform); filling area; center aisle area (with ingot mold station?), generator room, and ingot storage area (with both boxed and finished ingot storage, "pickled derby" shipping enclosure, ingot room with ingot table). Maintenance shop. "F" machine area (2 machines). UF_4 slag residues handled in residue recovery area, which included sump, filter, and recovery pit. Warehouse (blender hopper room, mold outgassing room(?), mold furnace room, loading platforms).
6E	116B	Electrical substation	
6E	116C	Slag (recycle) building	(Magnesium fluoride) Slag handling, grinding, and packaging. Had conveyor in (to?) packaging room; ball mill; rolling mill; elevator to C-3, hopper. Light dust contamination found in 1958.
6E	117 (including 117-1 and 117-2)	Service building: clean locker room (117-1), regulated locker room (117-2), laundry (117-2), security office (117-1), cafeteria (117-2), other offices and support services	The laundry and the regulated locker room were the only areas found in 1958 to be contaminated. In laundry: lobby, laundry storage room, and small and large sewers in the laundry pit. Locker rooms: turnstiles. Clean locker room: clean clothes room.

Table 1 (Continued)

Plant	Building	Process, function, or area	Notes
7	700	Warehouse, safety office, electrical and carpenter shops, temporary slug machining (fabrication) plant	The slug machining area had lathes and an inspection area. 700 was found in 1958 to be lightly contaminated except for the moderately contaminated slug machining area.
7	701	Slag recovery plant (aka Slag Separation Plant or Slag Processing Plant)	Found in 1958 to be heavily contaminated with loose material, especially with high beta, due to substantial amounts of "aged uranium". It had "Wilfey" tables, pumps, tanks, a ball mill, drum washer w/elevator and sump, and a filter.
7	703	Hydrofluoric acid vaults, HF tank farm	
7	704	HF feed and recovery, HF offgas treatment	704 had sumps, tanks, and a scrubber. 704-707 were all attached and were all found in 1958 to be moderately contaminated.
7	705	Main processing area for manufacturing UO_2, UF_4: packaging station area, maintenance shop, reactor area	Reactor area had UF_4 product hoppers, hydraulic pumps, and access platforms. There were a UO_3 feed station, a Hapman UO_3 conveyor, blenders, a UO_2($_3$?) packaging station(s), and a screw storage area. Localized contamination was found in 1958 around operating stations; green salt was caked on the roof. See also 704.
7	706	Warehouse for U materials (UO_2, UO_3, UF_4)	Had shipping platform. See also 704.
7	707	Ammonia cracking building (manufacturing H_2 and N_2 from NH_3)	See also 704.
7	708	Magnesium storage and packaging building	
7	709	HF refrigeration equipment and pump house	Contained refrigeration equipment for the GS(?) pit
7	710	NH_3 tank farm and pump house, ammonia storage	
7	711	Storage shed	
7 (7E)	712	Minor elements production facility	This had a change room, a "cold" (nonradioactive) lab, a "hot" lab (with hoods and a sump), and a production room (with pumper-decanters, mixer-settlers, settling tank, packaging station, sumps). It was used to process residues to obtain an ionium (Th-230) concentrate. Found in 1958 to have high levels of contamination.
7	SW Yard	Storage of drums, feed materials, and contaminated equipment	Moderate contamination was found in 1958, but it was highest where spills had occurred or equipment was stored.
7	700-701 Yard	Secondary gates in 700 yard; conveyor in 701 yard	Found in 1958 to have visible fixed contamination, higher near 701.
7	703(?), 704-707, and 711 Yards	Storage of contaminated equipment in all yards; Th-230 liquor drainage area and boxcar cleaning area in 711 yard	Screws and tubes were stored in the 704-707 yards. Yards were primarily concrete around Plant 7, except gravel around 703. Highest contamination (both alpha and gamma) found in these yards in 1958 was around 711: in 711 yard, Th-230 liquor was drained to the area by the RR tracks.
7	706 Yard		UF_4, scrap (??)
7	712 Yard	Mostly open storage, probably of contaminated scrap	Had lean-tos and an open storage bin. There was also a tank farm on a concrete pad at the south end of 712. The concrete in this yard was found to be heavily contaminated in 1958 from the activity from boxcars and contaminated scrap.

The information in this table is drawn from MED 1944p; FUSRAP 2003a ; MCW 1958; MCW 1959; Mason (1977); and ORNL 1981. Information regarding contamination levels found in 1958 and 1959 is from MCW 1958 and MCW 1959, which are reports on the results of Mallinckrodt's postoperation survey prior to the start of intensive decontamination.

Illegible areas in the references are indicated by dots (…..).

Buildings that were remained after the general demolishment of 1959-1961 are shown in Table 42.

Plants 1 and 2 were known collectively as "Main Plant"; Buildings 50, 51, 51A, 52, 52A, and 55 were known collectively as Building 51; and all of the Destrehan site was collectively referred to as Plant 6 at times.

Table 2. Summary chronology of operations at the Mallinckrodt St. Louis Downtown Site (SLDS) and at the St. Louis Airport Storage Site (SLAPS).

April 1942	Plant 2 was used to develop a batch process using ether to extract uranium as UO_3 from milled ore and then to convert the UO_3 to UO_2. Plant 1 was used for developmental work.
October 1942	Plant 4 was converted for use in the $UO_2 \rightarrow UF_4 \rightarrow U$ metal process. The ore$\rightarrow UO_2$ operations continued in Plant 2, while miscellaneous activities related to R&D work continued in Plant 1.
April 1943	Production of UF_4 from UO_2 began in Plant 4.
1944	Experimental extraction of uranium using pitchblende ores began in Plant 1.
1945	At some point in 1945 or early 1946, uranium operations at Plant 1 ceased. Plant 2 was apparently still used for some metallurgical-type work. Pitchblende ore began to arrive at the site in greater than research-level quantities in about May 1945.
1946	Plant 6 began operation in early 1946, with all ore$\rightarrow UO_2$ production operations shifted there. Uranium operations at Plant 2 ceased in early 1946, the work (including UO_3 milling) apparently shifting to Plant 6. Only Plants 4 and 6 were in operation.
1946-1947	AEC acquires SLAPS in 1946 and Mallinckrodt residues begin to be sent there for storage in about 1947.
1947-1951	Decontamination of Plants 1 and 2, with unrestricted release to Mallinckrodt in 1951.
1948-1949	K-65 residue is brought back from SLAPS for reprocessing. After about 1949, no more K-65 residue is sent to SLAPS, only low-radium residues.
1949–1950	In 1949-1950, major improvements were made in dust control at Plants 4 and 6, with the latter shut down during part of 1949-1950 for this. Ore milling at Plant 6 stopped in 1950.
October 1950	Plant 6E operations began. The $UF_4 \rightarrow U$ metal work shifted there from Plant 4, with the $UO_2 \rightarrow UF_4$ work remaining at Plant 4. Plant 4 was also modified for metallurgical-R&D work and became known as the Pilot Plant; some metal production (derbies, dingots) continued to take place there for experimental purposes.
1951	Plant 7 operations began in the first half of 1951. At that time, some UF_4 production work continued until perhaps 1952 at Plant 4, while the UO_3-to-UO_2 production at Plant 6 seems to have ended completely. Instead, UO_3 was sent to Plant 7 to be converted in a continuous process to UF_4. Some recovery and storage operations also shifted to Plant 7.
1952-1953	At some point, the continuous UO_3-to-UF_4 process began in Plant 7, after which time Plant 6 made only UO_3.
1954	The Ore Room and K-65 sampling operations in Plant 6 appear to have ended by about August 1954, possibly with the shipment of the last of the pitchblende ore (which would have been processed into at least 1955). It is not clear when the various Plant 6 pilot plant(s) began, but a 1954 start appears reasonable. Also, the Plant 6E Slag Separation Plant started in the first half of 1954. Some reversion of UF_4 to UO_2 and UO_3 was done in Plant 7.
1955	In 1955, thorium extraction from AM-7 residue began in Plant 7E and slag processing began in the Slag Separation Plant (Bldg. 701, part of Plant 7). Also, processing of residues to extract thorium began in early 1955 and the processing of a small amount of "enriched uranium" was done at Plant 7 early in 1955. Predigestion ore grinding ceased. Processing of high-grade pitchblende ore ceased and concentrates became the principal feed material.
1955 or 1956	In late 1955 or early 1956, dingots began to be produced in Plant 4, with derby production only intermittent; both were for experimental purposes.
Late 1956	All operations at Plant 4 ceased.
1957–1958	In 1958, all regular site operations ceased, with some Plant 7 activities conituing until July 1958. Postprocessing and shutdown-related activities continued into 1958.
1959-1962	The St. Louis site is decontaminated in 1959-1961, with unrestricted release of the site to Mallinckrodt in about 1962.
1962	AEC issues a license to a private entity, which then took over control of the SLAPS site.
1976 and 1978	Oak Ridge National Laboratory surveys the St. Louis Airport Site (SLAPS) for DOE.
1977	Oak Ridge National Laboratory surveys the St. Louis site (SLDS) for DOE.
1986, 1990	Applied Nuclear Safety does some surveys of the St. Louis site (SLDS) for DOE.
1995	FUSRAP takes over the St. Louis site (SLDS) for remediation.

Table 3. Principal changes made in sites, processes, and equipment.

Year	Plants	New method or form	Purpose(s)
1942-1943	4	Converted Plant 4	U metal production from UF_4; UF_4 production from UO_2
1946	6	Began operation of Plant 6	Increase production, reduce all types of exposures from processing of pitchblende ores
1946-7	SLAPS	Began operation of SLAPS	Storage of pitchblende residues
1947	SLAPS	Construction of K-65 storage shed	Control external dose, radon exposures
1948	4, 6	Start of formal health program	Track and reduce exposures
1948	6	Began to use ventilated ore railcars	Reduce radon exposures
1948	6	Began reprocessing the K-65 residue	Recover residual uranium; concerns regarding corroding drums
1949	4	Added ventilation to bomb step and recasting furnaces	Reduce deposition of volatiles and thus reduce beta exposures; reduce airborne dust levels
1949	4	Redesigned UO_2 and UF_4 handling methods (e.g., adding hoods to the tray loading, tray dumping, milling, blending, and packing operations)	Reduce airborne dust levels, eliminate hand scooping
1949	6	Added ore room shielding	Reduce gamma exposures
1949	6	Added remote control for filters	Reduce gamma exposures
1949	6	Added K-65 centrifuge shielding	Reduce gamma exposures
1949	6	Added shield tanks	Reduce gamma exposures
1949	6	Added C-3 cell block shielding	Reduce gamma exposures
1949	6	Revised ore house weighing process	Reduce gamma exposures
1949	6	Redesigned ore room dust control (drum weighing and deheading)	Reduce airborne dust levels
1949	6	Revised UO_2 handling (pneumatic unloading and conveying systems)	Reduce airborne dust levels, eliminate hand scooping
1949	6	Revised UO_3 handling (pneumatic unloading and conveying systems)	Reduce airborne dust levels; eliminate hand scooping
1949	6, SLAPS	Instituted limits on time spent handling ore and K-65 in railcars and at SLAPS	Control external and radon exposure to individuals
1950	4	Installed plantwide vacuum cleaning system	Enhance dust control and reduce airbornes
1950	6	Installed equipment decontamination room, respirator decontamination facility	Control contamination
1950	6E	Began operation of Plant 6E	Increase production, reduce all types of exposures
1951?	6, 6E?	Centralized exhaust ventilation	Reduce airborne dust levels
1951	7	Began operation of Plant 7	Increase production, reduce all types of exposures
1952-3	6	New Ledoux sampling labs with better ventilation	Lower airborne dust levels
1952-4	6	Use of pitchblende ore began to be phased out and soluble feeds were used increasingly	Use other available feeds
1953	6	Mechanical conveyor facilities provided in the Ore Room Addition for handling ore drum lids	Decrease airborne dust levels
1953	6	Increase in capacity of pneumatic gulping system in the Pot Room	Lower breathing zone and general area airborne dust levels
1953?	4	Enclosure around upper part of casting furnace	Reduce dust levels and beta radiation levels when furnace lid is removed
1953	4	Enclosure around blender and charging pit	Reduce dust levels in general area
1955	6E	All-purpose dust hood in the area adjacent to the smoking and maintenance areas	Reduce dust levels in breaking out ruptured derby furnace shells, rebuilding recast furnaces, dumping waste into drums, and dumping out drum to sort

Table 4. Types and quantities of material produced in association with Mallinckrodt uranium refining and related operations.

Material	Process or operation	Content and form notes	Amount
ORES AND OTHER FEEDS			
All ores	Eldorado processed all the Canadian and part of the Congo pitchblende; Vitro, all the vanadium tailings and some Congo ore (Eisenbud 1975). Some milled ore also came from Linde. Mallinckrodt would have received most of the Congo only during and just after the war; Canadian pitchblende and domestic ores were used after that. Pitchblende ores were apparently used exclusively until early 1955.		Mallinckrodt processed up to 50,000 tons of ore from 1942-1957 (DOE 1996). Typical amounts in 1945: Eldorado black oxide, 60,000-160,000 lbs/month, average 80,000 lbs/month; Vitro black oxide, 30,000 lbs weekly; Vitro soda salt, 20,000 lbs per 10 days (MED 1945a)
Belgian Congo ore (Q-11, AQ-4) and leach products (tailings concentrates)	Most of the pitchblende processed by Mallinckrodt was obtained as a concentrate from the Belgian Congo in 1944 (AEC 1967), processed at Middlesex (AEC 1951b), and shipped to St. Louis in 55-gal drums (AEC 1967).	Pitchblende ore, up to 65% (DOE 1997, MED 1949) or 70% (Dupree-Ellis et al. 2000) U_3O_8 by weight; up to 100 mg Ra/ton (Dupree-Ellis et al. 2000); averaged 135 mg Ra/ton (AEC 1949b); 0.185 ppm equilibrium Ra for Q-11 (60%) ores (AEC 1949b); 0.1 Ci/ton (total?), up to 70% U, average U concentration >25%, about 100 mg/ton ore for 25% U (Eisenbud 1975). Tailings: 30-50% U_3O_8 (AEC 1951b)	3400 tons U produced during wartime (through 1944?) (Eisenbud 1975); AEC (1951b) implies that Mallinckrodt was using only Congo ore, Congo ore tailings concentrates, and soda salt around 1951
Canadian pitchblende ores (Great Bear Lake, Port Hope)		Ores at perhaps 10% U (Eisenbud 1975); at 25-30% in 1951 (AEC 1951b) ores and U_3O_8 concentrate	850 tons U produced from Canadian ore in wartime (through 1944) (Eisenbud 1975);
Domestic ore and tailings: Uravan, Durango, Grand Junction, Naturita (Col); Monticello (Utah)		During wartime (through 1946?) vanadium tailings were used, not fresh ore (Eisenbud 1975); <1% U (Eisenbud 1975); shipped as a 20% ore sludge (Eisenbud 1975). The US stimulated domestic production from 1948 on; ores and lower-grade concentrate (DOE 1997). Colorado ores were carnotite type (Eisenbud 1975); N. American ore contained less than 1% U_3O_8 (AEC 1967)	850 tons U produced from the vanadium tailings (through 1944) (Eisenbud 1975). It is not clear how much if any of this was used by Mallinckrodt, except such as came as soda salt, etc.
U_3O_8 (milled ore or black oxide)	Ore usually arrived at Mallinckrodt in milled or concentrated form, as black oxide. However, DOE (1997) stated that Mallinckrodt produced black oxide, presumably at Plant 6.	Originally, (wooden?) beer barrels were used to transport the Congo ore from Eldorado, with wooden bracing in the railcars. This was unsatisfactory so metal containers (barrels) were used. The metal containers weighed about 100 lbs each when full. (MED 1945a)	Normal in-process inventory circa 1945 was about one month's production (MED 1946a).
Ore concentrates (MGX, etc.)	Special types of ore concentrates, e.g., the MGX, a magnesium uranate prepared in Africa from low-grade ore tailings (AEC 1955a)		
Sodium diuranate (soda salt)	$Na_2U_2O_7$. Packed in fiber containers (MED 1945a)	Vitro converted U ores to sodium diuranate (AEC 1951b; DOE 1997); some apparently also came from Anaconda, Durango, and Fernald (AEC 1956b). Fiber containers weighed about 75 lbs each when full (MED 1945a).	

Table 4 (Continued)

Material	Process or Operation	Content and Form Notes	Amount
REFINING PRODUCTS			
UNH (uranium nitrate hexahydrate)	An intermediate product in the digestion-extraction process: $UO_2(NO_3)\cdot 6\ H_2O$		Small quantities produced for research purposes as needed (AEC 1951b)
UO_3 (orange oxide)	Feed digested in nitric acid; precipitation of Ra-Pb w/ sulfuric acid (pitchblende ores); filtration to remove acid-insolubles; sulfate removal w/ Ba salt; centrifuging of solution; boiling of "liquor"; double extraction of U with diethyl ether; water wash to remove uranyl nitrate from ether; dewatering in Sperry press; boiling of molten salt to "hex liquor"; decomposition in pots to form UO_3; UO_3 "gulped" out of pot using vacuum system, packed in fiber containers for shipment.	Digestion took 4-8 hours (MED 1946a). Various solid and liquid wastes were produced, including most of the residues listed below. 2.5-gal fiber containers weighed about 75 lbs each when full (MED 1945a).	Sent to Clinton Engineer Works: 30,000+ lbs monthly prior to 15 DOE 1944 but 15,000 lbs weekly after that (MED 1945a). Plant 6 produced a monthly average of 21 tons in 1950 for R&D work on the continuous UO_3-to-UF_4 production process (apart from what went into the normal UO_3-UO_2 production process) and 146 tons in 1Q 1951 as the principal product for the new UO_3-to-UF_4 process (AEC 1951b).
UO_2 (brown oxide)	UO_3 was transferred from fiber containers into stainless steel drums, then weighed out on monel trays; reduced with cracked ammonia in batch electric (muffle) furnace to form UO_2 (MED 1949a); scooped from trays into fiber containers for transfer elsewhere (MED 1945a). Packed in fiber containers for transfer elsewhere.	This step took about 7 hours (MED 1946a). 2.5-gal fiber containers weighed about 75 lbs each when full (MED 1945a). There was 349 lbs on a 4-tray charge (MED 1944o).	By DOE 1942 Mallinckrodt was producing a ton a day (DOE 1996). Mallinckrodt used 32,000 lbs weekly (MED 1944o). Mallinckrodt produced 2/3 of the US total; 64% of what it made stayed at Mallinckrodt, 20% went to Harshaw, and 16% went to Linde (MED 1949a). In 1944-45, 20,000 lbs monthly went to Linde; 10,000 lbs/week went to Harshaw from Sept-Oct 1944, 28,000 lbs in Nov-Dec 1944, and 13,000 lbs/week after that (MED 1946a). The design capacity of Plant 6 was 200 tons/month, using ore @ 65% U_3O_8 (AEC 1951b). The monthly averages from Plant 6 were 94 tons in 1947, 246 tons in 1948, 204 tons in 1949, 207 tons in 1950 and 133 tons in 1Q 1951; large-scale production of UO_2 (as a separate product) ended in March 1951 (AEC 1951b). Plant 7's design capacity was 154 tons/month (i.e., could be produced if desired as a tapoff from the continuous UO_3-to-UF_4 process) (AEC 1951b).
UF_4 (green salt)	UO_2 placed on graphite or nickel trays in graphite or nickel boxes in the hydrofluorination reactor (furnace); HF gas passed over it to form UF_4; UF_4 removed from furnace and put through pulverizer; UF_4 packed into fiber containers (MED 1945a) or 5-gal containers for transfer to Plant 4 or 6E or another site (AEC 1949b).	Fiber containers weighed about 75 lbs each when full (MED 1945a). In 1944, one control sample was taken per charge; there were 107 runs per week; 535 lbs per week was sent to a recovery tank; and there were 135 lbs per drum and 3375 lbs per lot (MED 1944o).	Mallinckrodt was the major producer of UF_4; up to 1949, some UF_4 came from ElectroMet (DOE 1997). Normal in-process inventory circa 1945 was 2 days' production (MED 1946a). In 1944, 37,000 lbs weekly was produced, of which 11,000 lbs was used at Mallinckrodt to make metal (MED 1944o). In 1945, 8000 lbs/week was being sent to Harshaw and 20000 lbs/week to Iowa State (MED 1945a). Average monthly production in Plant 4 was 76 tons through Dec 1946, 131 tons in 1947, 147 tons in 1948, 151 tons in 1949, 169 tons in 1950, and 189 tons in 1Q 1951 (AEC 1951b). Plant 7's design capacity was 225 tons/month originally, 375 after expansion (AEC 1951b) (unclear if expansion took place).

Table 4 (Continued)

Material	Process or Operation	Content and Form Notes	Amount
U metal in derby form	Reduction with magnesium in furnace to U metal (slag + derby); slag chipped off to leave derby	In 1944-1949, there was 135-140 lbs of UF_4 per bomb, along with 55 lbs of liner (MED 1944o, AEC 1949g). A biscuit weighed 92 lbs and was associated with about 122 lb of slag, of which 10 lb was metal; about 80 lbs of sawdust a week was produced; 15 and 2 lbs of samples were sent (weekly?) to plant and outside labs respectively (MED 1944o).	In 1944, 7500 lbs of biscuit was produced weekly (MED 1944o). Normal in-process inventory circa 1945 was one week's production (MED 1946a).
U metal in billet form	Derby was vacuum recast to form the billet		Normal in-process inventory circa 1945 was one week's production (MED 1946a). In 1945, billets were shipped out every two weeks to Hanford in a carload lot of about 30,000 lbs, from a weekly production of 13,000-15,000 lbs (MED 1945a). Average monthly production in Plant 4 was 33 tons through December 1946, 84 tons in 1947, 102 tons in 1948, 100 tons in 1949, 169 tons in 1950, 189 in 1Q 1951; average monthly production in Plant 6E was 83 tons in 4Q 1950 and 162 tons in 3Q 1951; the latter was said to be AEC's entire requirement for metal at the time (AEC 1951b). Plant 6E's design capacity was 150 tons/month originally, 265 tons/month after the expansion of 3Q 1951 (AEC 1951b).
U metal in dingot form	A dingot was a single massive ingot needing no recasting. The dingot-making operation was most similar to the regular derby-making operation. After the chipping step, the dingot was pressed into a slab. (AEC 1956a)	In late 1955 or early 1956, this replaced the derby-billet operation, except for occasional experimental derby production in Plant 4, per AEC (1956a). But AEC (1956c) reported that in mid-1956 (all?) billet recasting was being done in 6E, using new graphite molds. A dingot weighed about 3300 lbs (AEC 1956a).	
Radioactive metal samples	"Small" samples were sent to Clinton Engineer Works (Y-12) packed in glass tubes and packed into cardboard boxes. "Eggs" were sent to the Chicago Area Engineer (MED 1944o) packed 8 to a box in wooden cardboard boxes. (MED 1945a)		A "small sample" was sent daily to Y-12; eggs were sent in 2-3 lots daily, 63 lbs to a lot. (MED 1945a)
"Tubealloy"	Early synonym for uranium (Fleishman-Hilliard 1967), presumably as the metal. Manufactured by Mallinckrodt and shipped to the Chicago Area Engineer (of MED).		150 lbs shipped daily to Chicago (MED 1945a)
RECYCLED AND RECOVERED MATERIALS			
Organic solution of $Th(NO_3)_4$	AM-7 residue was processed via a nitric acid strip to concentrate Th-230 in Plant 7E; solution was sent to Mound, residue (AM-9) returned to storage.	Concentrate had about 1 kg of Th-230, 0.7% alphas from Th-227 & daughters, <0.03% from Th-228.	350 tons of AM-7 processed for Th- 230 (FUSRAP undated a, AEC 1959); 3600 gal (13,630 l) of Th-230 solution sent to Mound (DOE 2002).
U slag (derby)	Derby slag was scalped or cut off derby and separated into a MgF2 part and a C-liner part; the MgF_2 part was sent to Vitro for recovery; the C-liner part was stored as waste. Eventually both parts were processed at Mallinckrodt.	Some of the C-liner slag was apparently reprocessed to recover U from about 1953 on (AEC 1954f). In 1955, an interim pilot plant at Plant 7 was built to scalp off most of the U-bearing segment of the MgF_2 part.	

Table 4 (Continued)

Material	Process or Operation	Content and Form Notes	Amount
U slag (recast)	Recast slag was recovered as residue from the recast furnace.	As the uranium melted, the slag floated to the top of the crucible and beta-emitting Th-234 and Pa-234 (UX1 and UX2) sublimed and condensed on the underside of the furnace lid; recast furnace slag was thus highly concentrated in UX1-UX2 (AEC 1949, Eisenbud 1975)	
U slag (dingot)	Dingot slag was broken off and swept down through a floor grill, collected on a conveyor, put through a grinding series, drummed, and sent to the Slag Building (701) for reprocessing. (MCW 1949h)		
U scrap	Miscellaneous material, including some residues, ash from incinerating the UO_3 fiber containers, and metal; some oxide and nitrate scrap was sent from the Chicago Area Engineer (MED); some scrap was sent to Du Pont. C-2 scrap was packed in 50-gal whiskey barrels; C-1, C-3, C-4, C-5, and D-2 scrap was packed into 5-gal containers with a steel clamp top. (MED 1945a)		Scrap from Chicago Area Engineer, 1945: 1500 lbs oxide type per 2 months, 1500 lbs nitrate type per 4-5 months. Scrap shipped to Du Pont as follows. C-1, C-3, C-5, D-2: 80,000-90,000 lbs total per 4-6 weeks; C-2: 80,000-90,000 lbs per 5-6 weeks; C-4: 100,000-120,000 lbs per 4 months. (MED 1945a)
K-65	One source suggests that this residue was "reworked to recover additional uranium values" (i.e., reprocessed?) before transfer to Lake Ontario.	Radium-bearing residue	
Sawdust and fiber containers	Fiber containers were incinerated and processed to recover uranium; sawdust was apparently processed similarly.		
RESIDUES AND OTHER WASTES			
Pitchblende raffinate (AM-7)	"Airport cake"; produced as part of the pitchblende digestion process (extraction raffinate); see also Sperry cake	0.2% U (AEC 1949b); 0.15% U (AEC 1959); 29 ppm Th-232, 3.8 ppm Th-230 (11.6 isot %) (Figgins and Kirby 1962). Pitchblende residues:Th-232/Th-230 ~ 8. In AEC (1960), sampling in June 1953 showed highest sample at .0038% th and 0.14% U	33000 lbs/day (AEC 1949b); 74K tons total, 113 tons U stored through at least 1965 (AEC 1960; AEC 1964; ORNL 1979)
De-thoriated pitch-blende raffinate (AM-9)	Residue after processing AM-7 for ionium (Th-230)	0.12%U (AEC 1959). Carnotite residues: Th-232/Th-230 ~ 15-20 (AEC 1949b)	
Domestic ore raffinate (AM-10)	"Airport cake"; produced as part of the non-pitchblende digestion process	Carnotite residues: Th-232/Th-230 ~ 15-20	32.5K tons total, 48 tons U stored through at least 1965 (AEC 1959, AEC 1960; ORNL 1979)
Pb-Ra precipitate (K-65, gangue lead cake)	"Lead cake"; a Ra-bearing residue produced as part of the pitchblende digestion process (resulting from addition of sulfuric acid); sent to Lake Ontario or the airport for storage	750-900 mg Ra/ton (AEC 1949b); 750 mg/ton Ra and 0.2% U (AEC 1949b); up to 300 Ra mg/ton (Eisenbud 1975)	8000-12000 lbs/day (AEC 1949b)
Ba sulfate cake (AJ-4)	Produced as part of the digestion process (resulting from addition of barium carbonate)	0.28% U (AEC 1959); 1 mg Ra/ton, 0.1% U (AEC 1949b); .1% U, 1E-9 g Ra per g U (AEC AEC 1949m)	6800 lbs/day total AJ-4 (AEC 1949b); stored: 1.5K tons total unleached (wit 22 tons U), 8.7K tons total leached (with 7 tons U) (FUSRAP undated a, AEC 1960), i.e., 10.2K tons total (with 29 tons U (AEC 1959; ORNL 1979)

Table 4 (Continued)

Sperry cake	Produced in Sperry press from aqueous tails from the ether extraction step; some later sent to Mound for processing to extract Pa; apparently a subset of AM-7	Good source of Pa-231 (2 g/20 tons); per Salutsky (1956), this was a cake @ 50% solids, 1.6 g/cm^3 density, 0.1-0.3 ppm Pa-231	20 tons (AEC 1959)
Vitro residues (C-6)	Sent from Vitro (?) for storage at the airport	0.33% U (AEC 1959). C-6 and V-10 were stored in a total of 2400 drums (FUSRAP undated)	290 tons total, 1.9 tons U (AEC 1959)
Bomb furnace residue (C-Special)	This was from the Mallinckrodt and ElectroMet bomb furnaces and appears to be the same as the "C-liner slag" below. (AEC 1949b)		
U-containing sands, precipitates (V-10)	Captured from the Japanese	C-6 and V-10 were stored in a total of 2400 drums (FUSRAP undated)	60 tons total, 0.2 tons U (AEC 1959)
Dolomite liner (C-liner or C-liner slag)	Slag material, mainly dolomite, remaining after the derby slag was separated from the derby and the top (MgF_2) part of the slag was detached	<2% U (AEC 1959); 1.6% U (AEC 1959). This remainder slag was produced until early 1953, when dolomite was replaced by recycle magnesium fluoride. Some was reprocessed to recover U from about 1953 on (AEC 1954e).	7800 tons, 122 tons U (AEC 1959); 4000 tons, 49 tons U I 1964 (ORNL 1979)
Interim Residue Plant Tailings (C-701, D-701)	Resulted from scalping the U content from the Mg fluoride slag from 1955 on; 701 apparently refers to Bldg 701 (AEC 1956d)	2.1% U (AEC 1959)	7K tons total, 144 tons U (AEC 1959)
30- and 55-gallon drums	Empty drums, stored as contaminated waste		55000 (AEC 1959)
Metal and alloy scrap	Stored as contaminated waste		3500 tons (AEC 1959)
Aqueous tails	From ether extraction step; filtered and treated with lime; precipitate become airport/Sperry cake, filtrate disposed of as liquid effluent		

See the text for process details. See the keywords table (Table 5) for other code numbers and terms.

Table 5. Functional and process keywords and codes.

Plant	Keyword or code	Note
	2	MED hazard index number for soluble uranium material
	4	MED hazard index number for insoluble uranium material
	6	MED hazard index number for nitrous fumes
	14	MED code for Building 51
	16	MED hazard index number for hydrogen fluoride
	32	MED hazard index number for handling of metal
	38	MED code for the laboratory area in Plant 2
	51	See “Building 51” below
	52	MED code for Plant 4
	128	MED hazard index number for hydrogen fluoride gas
	162, 172, 182	Black oxide (U_3O_8); could appear as “Chemical 162”, etc.
	256	MED hazard index number for radium
	264, 272	Orange oxide (UO_3); could appear as “Chemical 264”, etc.
	306	Brown oxide, i.e., UO_2; could appear as “Chemical 306”
	512	MED hazard index number for radon
	1024	MED hazard index number for solvents
	2048	MED hazard index number for radiation
	4-bagger	Type of dust collector
	A	In film badge records, denotes “absent”; elsewhere, denotes non-specification grade black oxide (U_3O_8)
6	Acid	Acid addition: in ore digestion (nitric) or Pb-Ra precipitation (sulfuric)
7	Adams	A type of polishing filter used in Plant 7
6	AEC	Atomic Energy Commission
	Airport	SLAPS, the former airport site later used for waste storage by the AEC
6	AJ-4	Barium sulfate cake produced from pitchblende ore (ore-to-UO_3)
	AJ-7	Another barium cake
6	AM-7	Raffinate cake produced by treating pitchblende ore
6	AM8	Unclear what this indicates
4,6,6E,7	Area M	Area mechanic
6	Assist LO	Assisting the lead operator
6	AQ-4	Pitchblende ore
4	Ballard	Vertical turret lathe (manufactured by Ballard) used to scalp the dingot
6	Barium	Barium salt addition
	Beets(?)	See Egg
4, 6E	Billet	Final form of uranium metal, produced by recasting from derbies
6	Bird centrifuge	Solid-bowl centrifuge (manufactured by Bird) used to separate liquids and solids
	Black oxide	U_3O_8
4, 6	Blender	Apparently ore in Plant 6; UF_4 + Mg in Plants 4, 6E; slag in Plant 6E
4, 6E	BM	Bottom man
6	Boildown	A step between digestion and ether extraction
4	Bomb	Container for Mg-UF_4 in the metal reduction process
4, 6E	Bomb step	The UF_4-to-derby process
4, 6E	Bottom	Lower (furnace or F machine)
4, 6E	Bottom man	Bottom man in the YM-5 production process -- would physically enter the bottom part of the furnace in Plant 4
4	Box	Crucible holder (external assembly)
6E	Breakout	Removal of the derbies from the bombs
	Brown	Brown oxide, i.e., UO_2
	Brown monster	Apparently the Rockwell furnace(s) (UO_3-to-UO_2)
	Building 51	The 50 series of buildings at Plant 2 (i.e., 50, 51, 51A, 52, 52A, and 55)
	Building K	Apparently Building K1E in Plant 1
6E	Burnout, burn	Crucible burnout (heating)
	C	On film badge records, denotes no badge issued (“clean”?)
6	C-	When followed by a number, denotes material collected by a given dust collector or filter press or a type of scrap
6	C-3 (C-3A, etc.)	C-3 cell block operations (e.g., centrifuging, packing) related to use of the carbonate leaching process to recover uranium from Feinc filter cake (K-65); also dust collection related to this
	C-27	Derby chippings (residue)
	C-55	As “Chemical K-35”, etc., denotes black oxide (U_3O_8) (may be scrap)
4, 6E	Cage	Scrap holding area
4, 6E	Cage man	Handled billet and other metal scrap, degreased billets
6E	Cap	Valved top put on the Mg-UF_4 drum for jolting
	Cats	High-grade ore
	CB	On film badge records, denotes contaminated badge and film

Table 5 (Continued)

Plant	Keyword or code	Note
6	CEN, Cent, Cntr	Centrifuge. Also abbreviated CNF?
	Chemical	Start of some code names; was followed by letters or numbers
4	Chipping	Removal of the slag from the derbies using a manual or power hammer
	Classifier	Equipment used in the Ore Room apparently to sort ore pieces by size
---	Cleanup	Generic for area or item cleanup: see associated keyword (e.g., TA-7)
	C-liner	Dolomite slag left after the bomb is opened and the derby removed
	C-Special	Liner slag left on bomb and possible also derby (had to be chipped off)
6	Cloth	Cloth (actual or metal) used to filter solids from liquid streams
	Cl Up	Cleanup, i.e., cleanup of process area
6	CM	Cloth man?
	Cocoa	Brown oxide, i.e., UO_2
4, 6	Continuous furnace, Cont furn	Furnace for processing UO_3 to UF_4 in a continuous run (in Plant 4, experimental process in Pilot Plant)
	Croppings	Chips or pieces taken off derbies, billets, and dingots
6E	Crucible, Cruc	Crucible or crucible assembly (6 should probably be 6E)
	Crusher	Probably the UO_2 crusher (mill)
	CS	Refinery feed material that was an impure calcium uranate
	C-Special	Magnesium fluoride slag formed on top of the derby
	CX	Calcium uranate leach product from the processing of ore tailings at African mills; sent to Mallinckrodt for laboratory research and pilot-scale recovery of the uranium
	D	Radium (the element)
6	D-	When followed by a number, denotes a given dust collector or filter press OR the material collected there or a type of scrap
7	D-30	Dust collector for the FMFL product (dust is the product)
	D-701	Residues collected in the slag grinding area. shipped to slag recovery
6	DA	Dissociated (cracked) ammonia or Digest area
6,6E, 7	Decontamination	Generic
	Deheading	Same as Delidding
	Delidding	Removing the lid of a drum, usually of ore
4, 6E	Derby	Crude uranium metal form produced from UF_4
6	Digest, DIG, Dig	Digestion process (ore dissolution by acid), digestion area, digestors
4	Dingot	"Direct ingot", an extra-large ingot produced instead of derbies and billets
	DR	???
	DX	Probably decontamination work
	E	Designates the Mallinckrodt plants in St. Louis
	Egg	1.9-kg egg-shaped piece of U metal produced for external assays
6	Ether, Ether House, EH	Ether storage, handling for U solvent extraction process
4, 6	Extra, Extra Man	Extra (floating) chemical operator for a process or area (4, 6); possibly also "extraction" (6)
6	Extraction	Extraction of uranium in the ether extraction process
	F	Generic feed material designation for types without a code name
4, 6E	Fce	Furnace (metal-making areas)
	FD	On film badge records, denotes factory-damaged film
6	FE, Fe	Feinc (FE Inc) filter (equipment or area)
6	Feed	Ore or other feed material; also could indicate main stream of process (i.e., not residue)
6	Feinc	String discharge rotary vacuum filter (manufactured by Feinc) used to separate solids from liquids
	FF	On film badge records, denotes film fogged, torn, or open (in badge?)
6	FH	Feed hopper?
6	Filter press	Press type of filter for separating solids from liquids and leaving a dewatered cake
	Fin	Slag or magnesium burr on billet, bomb shell lid, etc. that had to be chipped off
6E	F Machine	UF_4-to-derby bomb filling ("F") machine: the top is used for the UF_4, Mg mixing, the bottom for filling the bomb
7	FMFL	Fluorinated MgF_2 liner, used as a low-hydrogen liner in dingot bombs
4, 6	FR, Furnace, Furn	Furnace Room
	Gangue, gangue lead cake	The Pb-Ra cake also known as K-65
	GL	In film badge records, denotes "gone through the laundry" in context of film condition; denotes work with gangue lead cake in context of worker area
6	GLC	Gangue lead cake, i.e., the Pb-Ra cake also known as K-65
	Green	Green salt (UF_4)
6	Gulping	Vacuum-sucking UO_3 out of the pot it was produced in into drums
	GWT-5	Uranium metal eggs (test samples)
	GY-3	U_3O_8 (black oxide), having a minimum assay of 97% U_3O_8
	H-20	??? (H_2O, i.e., water?)
7	Hapmann, Hapman	Conveyor for loose material; typically discharges into a feed hopper

Table 5 (Continued)

Plant	Keyword or code	Note
6	Hex, hex liquor	Uranyl nitrate hexahydrate in an aqueous solution
6E	Hoffman	Dust collector (manufactured by Hoffman)
All	House	Generic for dedicated additive handling and storage building or area
4, 6E	Ingot	Same as billet
6	Instrument, Instru, Instr	Instrument Shop
	Ionium	Thorium-230
	Iron maiden	C-Special, while still attached to derby
4, 6E	Jolter, jolting	The jolter-filling machine in UF_4-to-U metal production, also the operator; the operation
	Juice	Orange oxide, i.e., UO3
	K-35, K-82	As "Chemical K-35", etc., denotes black oxide (U_3O_8)
6	K-65	K-65 (Ra-Pb) residue (gangue lead cake) from the (pitchblende) ore-to-UO3 process
6E	KB-2	Derby form of uranium metal
4	Label	Apparently labeling product containers
6	Laboratory, Lab, LAB	Any of several laboratories (Analytical, Shotgun, Ledoux, etc.)
6	Laundry	For both contaminated and uncontaminated clothing; Mallinckrodt had own laundry from ~ 1948 on
	LB	In film badge records, denotes film that was opened (in badge?)
	Ld	Loading (e.g., TA-7)
	LF-9	Brown oxide (UO_2)
	LFD	In film badge records, denotes film lost in the darkroom (torn open)
	LFP	In film badge records, denotes film lost in plant
	LG	Lead gangue? See GLC
6	Ledoux (LeDoux) Laboratory	The raffinate and uranium assay laboratory in Plant 6
6	Liquor	Extracted liquid concentrate, usually after removal of undesirable materials as solids
	LL	Ledoux Laboratory
	LO	Lead operator
4, 6	Loading, Load, Ld	Generic: see associated process keyword, e.g., TA-7
	Location E	The Mallinckrodt St. Louis site (SLDS)
	M	Powdered magnesium metal, work in the metal-making (derby and billet) areas, or maintenance (depending on context)
6	M(+number), M-(+number)	(1) Designates tank(s) used in processing. (2) Designates a type of development work, e.g., M-1 for slag liner work, M-2 for mold improvement, and M-7 for crucible testing
	M-20	Step or tank during which barium sulfate was added
	ME	Refers to processing of AM-7 raffinate to concentrated liquid Th form (Minor Elements)
	MFG, Mfg	Manufacturing: generic for Plant 6 and Plant 4
6	MGX, MgX, MGX Process	Refinery feed material that was an impure magnesium uranate from the Belgian Congo
4	Mag Room	Magnesium [Storage] Room
1, 2	Main Plant	Plants 1 and 2
6, 6E	Maintenance, M, MNT	Maintenance, presumably process maintenance
	ME	Refers to reprocessing of raffinate to a feed concentrate
7	MFL	MgF_2 liner (for use in dingot bombs); loosely, also the associated slag used (recycled) in the liner
6	Mikro	Dust collector (manufactured by Mikro)
6	Mill	See Rod mill
	Mtns	Maintenance
4	Muffle	Batch electric (muffle) furnace used to reduce UO_3 to UO_2
	Mx (note lower case)	Uranium (generic for the element?)
	MX (note upper case)	See MGX
	My	Radium; also, used to indicate a breath radon measurement (since this measurement was used to infer radium body burden)
	Mz, MZ	Radon-222
6	NA, NAH	Nitric Acid House
6	Neutral	Neutralizing uranium solution (in acidification step?)
6	Niagara, Nia	Pressure leaf filter (manufactured by Niagara) used to separate solids from liquids
6	NOK	In the re-extraction process, the OK liquor contained the uranium and the NOK liquor contained the dross (after filtration, it became raffinate).
6	Ntns	Maintenance (Mtns)?
4	Office, OFF	Generic for office
	OH	Hydroxide (e.g., to neutralize excess HF and recover uranium)
6	OK	In the re-extraction process, the OK liquor was the uranium-containg liquid sent to the boildown tanks
6	Oliver	Filter press (manufactured by Oliver)
	Orange, orange juice	Orange oxide, i.e., UO_3

Table 5 (Continued)

Plant	Keyword or code	Note
6	Ore, Ore Room, OR	Ore processing, storage before use; also handling of residues
	OZ	Electrically fused dolomite
4, 6, 7	Pack, packing, packaging	Appears to be generic for packaging
6	Pangborn	Type of dust collector (K-65/Ledoux Sample Lab; ore grinding room; C-3)
6	Peterson	Type of filter, often in a hood; at least some was used to filter NOK liquor to produce the raffinate
	PH	Power House
6E	Pickling	Soaking derbies in acid to remove surface impurities (scale, oxides)
All	Pilot Plant, PP	Plant 4's name (for metallurgical research and developmental UF_4 furnace work), after metal production moved to 6E; Plants 1 & 2, around the time Plant 6 started up; a slag recovery pilot plant in 6E; or an unspecified pilot plant at 6 (must be taken from context)
	Pk	Packing (packaging) of a product form
All	Pl	Plant (e.g., Pl. 7 is Plant 7)
	Plant 10	The later name of the Plant 4 area (after Plant 4 was dismantled)
2	Plant 51	Building 51 operations in Plant 2
6E	PLO	Process Lead Operator?
6	Pot, Pot Room	Denitration pot room (producing UO_3)
6	Press	Filter press
6	Production Engineering, Prod Eng, Prod Off Eng	Generic for production/process engineering work
6	Production Office, PO	The MCW [Main] Production Office
	Project (+ number)	Project 89 was Plants 1 and 2; 90, Plant 4 green salt operations; 91, Plant 4 derby production; 92, Plant 4 recast operations
	Q-11	Pitchblende ore, other high-grade ore
	QM-2	Orange oxide (UO_3)
6	Raffinate, Raff	Residues (mainly the cakes)
6	Railcar	Railroad car used to transport ore, K-65 residue, and sometimes scrap
6	Rapping	Knocking a dust collector (usually the Pangborn) to loosen collected material for removal
4,7	Reactor	Reaction vessel/heater in which UO_3 is converted to UO_2 with cracked ammonia
4	Recast, Recast Furnace	Where derbies were recast into billets
4	Receiving & Shipping	Generic? The main Receiving & Shipping area was in Plant 6, but there may have been plant-specific areas
6	Recovery, REC	Nitric oxide recovery (6); slag recovery (7); may have indicated other types of recovery at other plants
	Regulated	Refers to radiologically controlled areas, e.g., the regulated locker room and the general locker room
	Regulus	Same as Derby
6	Reverter (riverter?)	Unclear. Appears to be a type of pump or processor used in the recycling of dust collector material
7	RMF	Recycle magnesium fluoride (from bomb liner residue)
6E	Rockwell	Rockwell furnace (UF_4-Mg reduction to derby metal)
6	Rod mill	Piece of equipment used to grind ore
	Rolls	Billets
6	Rover	Extra pair of hands or swing man?
	S	As "Chemical S", denotes sodium salt (sodium diuranate, Na2U2O7)); in urinalysis records, denoted sulfate (work)
4	Salt bath	Bath in which a dingot is put to heat it
	Sample Room	Any of several sample rooms, e.g., the K-65 Sample Room
6	Sampler, Spl	Generic for sampling or work in a sample room
SLAPS	Sand	(1) cake residue or (2) uranium-containing sands captured from the Japanese
6E	Saw	Sawing off a portion of the metal billet as a sample
6	SC-5	Uranyl nitrate hexahydrate (UNH)
6E	Scalping	Mechanically slicing off slag from the external surfaces of a billet
6	Scrap	Usually, scrap left over after cleaning the derbies; miscellaneous scrap
4	Semi-works	Term for a facility within a plant, on the scale of or slightly larger than a pilot plant (specifically, the dingot operation in Plant 4)
6	Skip hoist	Hoist used to raise ore drums, dump them into raw ore bin feeding (ore) rod mill
6E	Slag	Byproduct from the Mg-UF_4 reduction step (mostly MgF_2)
7	Slag Processing Plant	Same as Slag Separation Plant
[4]	Slag Shed	Storage of the chipped-off bits of slag?
	SLAPS, SLAPSS	Sl. Louis Airport Storage Site
6E	Slye	Dust collector (manufactured by Slye)
6	Shotgun Laboratory	Shotgun sample preparation laboratory
6	Shotgun Samp Prep	Shotgun sample preparation (lab)
6	Soda salt	$Na_2U_2O_7$ (sodium diuranate, a feed material); perhaps other soluble feed material

Table 5 (Continued)

Plant	Keyword or code	Note
	SP	In film badge records, denotes film spoiled in the darkroom (development) process
6	Sperry	Filter press (manufactured by Sperry); also, the cake produced (same as or subset of AM-7)
	SR	Storeroom
	SS	Stainless steel presses, i.e., the plate and frame filters
	SSP	Usually refers to stainless steel (filter) presses; may indicate Shotgun Sample Prep Lab
	ST	Uranium metal scrap
6	Storeroom	Generic; the main storeroom was in Plant 6
6	Stripper	Unclear; probably piece of equipment rather than operator name
All	T	Generic code term for uranium, including as metal (T metal), in compounds (e.g., TO_2), and as a daughter indication (e.g., TX1)
6	T-3	Typo for C-3?
4	TA-7	Green salt (UF_4)
	TA-7R	UF_4 produced from UO_2 in the experimental continuous reactor
	Talcum	UF_4
6	Thawhouse	Building where ore was thawed in winter before undrumming
6	Thief	Sampling device that opens at a desired depth into the material
6	THP	THP ether?
6	Thumper	Device to “thump” feed drum to dislodge material during digestor loading
4, 6E	TM	Top man, Top-off man, etc., in the YM-5 production process
4, 6E	Top	Refers to the upper or top recasting furnace or the top F machine
4, 6E	Top man	Top man, Top-off man, etc., in the YM-5 production process
4, 6E, 7	Topping	Refers to the operation of adding material to ensure proper fill
	Tubealloy	Uranium metal (generic term also used roughly to indicate any uranium)
	Tumbler, tumbling area	UO_2 breakup (crushing) area
	U	In film badge records, denotes “unidentifiable” in context of film condition; elsewhere, usually denotes uranium
6, 7	U-CON, U-con	Uranium concentrate slurry produced in the Slag Separation (Processing) Plant (7) from reject MgF_2 material and sent to Plant 6 as a feed material
6	UNH	Uranyl nitrate hexahydrate ($UO_2(NO_3)_2 \cdot 6\ H_2O$)
	Unld	Unloading (e.g., TA-7)
6E	Utility	Utility man or “floater” who filled in as needed
	UX1, UX2	Old names for Th-234 and Pa-234m respectively
	V	In film badge records, denotes “on vacation”
	V-4	A form of soda salt used as feed material
	W	In film badge records, denotes “wet from unknown reason”
All	Warehouse, WH	Generic: various warehouses were used, with the main one in Plant 6 and later in Plant 7
4	Weigh, check weigh	Generic: feed and products were weighed at various points
6E	Wilfey	Shaker table (manufactured by Wilfey) used to separate high-U slurry from low-U material
	X	Generic code term for uranium, including in compounds (e.g., XO_2)
	Yard	Open areas outside buildings and guard stations; used to store drums, unload railcars; even used postoperations for decontamination
	YB-1	UO_2 produced from UO_3 in the experimental continuous reactor
	Yellow cake	The generic form of uranium ore, somewhat preprocessed
4	YM-5	Billet form of uranium metal

Table 6. Thorium and daughter content of the AM-7 residue ("airport cake").

Material	Concentration, ppm	Mass, grams	Specific activity, Ci/g*	Total curies in ore	Notes
Ore	---	3.18×10^{8}	---	---	350 tons processed (see Table 4)
Th-230	3.8	1,208	0.0202	24.4	Concentration: Figgins and Kirby 1962
Th-232	29	9,222	1.09×10^{-07}	0.00101	Concentration: Figgins and Kirby 1962
*From Shleien 1992					
Isotope	**Half-life**	**Activity after 15 years, Ci**	**Percentage of original**		**Notes**
Th-230 Chain					
Th-230	77,000 years	2.44×10^{1}	~100%		
Ra-226	1,600 years	1.58×10^{-1}	0.65%		Ignoring Ra-226 decay
Rn-222	3.82 days	1.58×10^{-1}	0.65%		Ignoring Rn-222 decay
Po-218	3.05 minutes	1.58×10^{-1}	0.65%		Ignoring Po-218 decay
Pb-214	26.8 minutes				
Bi-214	19.9 minutes				
Po-214	164 microsecs				
Pb-210	22.3 years				
Bi-210	5.01 days				
Po-210	138 days				
Th-232 Chain					
Th-232	1.41×10^{10} years	1.01×10^{-3}	~100%		
Ra-228	5.75 years	8.46×10^{-4}	84%		Ignoring Ra-228 decay
Ac-228	6.13 hours	8.46×10^{-4}	84%		Ignoring Ac-228 decay
Th-228	1.91 years				
Ra-224	3.66 days				
Rn-220	55.6 seconds				
Po-216	0.15 seconds				
Pb-212	10.6 hours				
Bi-212	60.1 minutes				

Fifteen years is assumed to be the maximum decay time (1942-1957).

As the second part of the table shows, in 15 years secular equilibrium has not been reached for either the Th-230 chain or the Th-232 chain, although Th-232 is almost there. Thus only the activities of the first few members are shown.

Table 7. Airborne uranium particle size in process areas.

Area	Location or source type	Method*	Average concentration, mg U/m^3	Mass median particle size, microns	GSD
Mallinckrodt UO_2 Production Area (Rochester 1948b)					
UO_3-to-UO_2 conversion	<1 foot of the blow pipe	F	2.14	1.2	2.34
Tumbling	Vicinity of furnace, tumbler tray rack	F C	.11-.46 .64-.93	1.4-1.45	2.5-3.2
	Further from furnace, tumbler rack	F C	.069-095 .41-.53		
	Near skip hoist	F C	2.8-4.2 .59-.69	1.5-1.9	2.45-2.6
	4 feet from skip hoist	F C	0.75 3.5		
	Back of the skip hoist	F		2.6	2.65
Fiberpack packaging		F, C	.060-2.2	.72-3.48	2.96-3.03
Warehouse	Closed containers of UO_2	F	.017-.033	1.1	2.3
General (Non-Mallinckrodt) Foundry (Sanders 1975, Table 2)					
Foundry	Depleted U Enriched U Enriched U	--- --- ---	--- --- ---	2.8 ± 2.7** 3.3 ± 2.2** 2.1 ± 2.0**	--- --- ---
Machining	Depleted U, milling dry	---	---	3.0 ± 2.3	---
Extruding	Depleted U	---	---	3.2 ± 2.7	---

* This refers to the sampling method. F: filter paper (with air sampling pump) . C: cascade impactor

** 88% of these particles were from particles less than 7 µm.

Table 8. Uranium dust concentrations, Plants 4 and 6, in alpha dpm/m^3 (Mason 1958a, Tables 1, 2).

	Plant 4				Plant 6									
							UO_3 production				UO_2 production		Misc
Year	UO_2 Production	UF_4 Production	KB-2 Production	YM-5 Production	Warehousing	Ore grinding	Feed digest	Milling	Pot room	Packaging	Load	Unload	Packaging
1943	2,100	2,380	1,190	2,520	---	---	---	---	---	---	---	---	---
1944	2,100	2,380	1,190	2,520	---	---	---	---	---	---	---	---	---
1945	2,100	2,380	1,190	2,520	---	---	---	---	---	---	---	---	---
1946	2,100	2,380	1,190	2,520	210	13,300	420	12,600	7,770	1,400	5,320	3,150	11,270
1947	2,100	2,380	1,190	2,520	210	13,650	420	12,600	7,770	1,400	5,320	3,150	11,270
1948	2,100	2,380	1,190	2,520	210	13,650	420	12,600	7,770	1,400	5,320	3,150	11,270
1949	420	280	280	770	210	13,650	420	12,600	7,770	1,400	5,320	3,150	11,270
	---	---	---	---	70	350	70	0	4,200	700	1,400	700	350
1950	280	140	210	770	70	350	70	*	770	700	1,400	700	350
	---	---	---	---	28	350	70	---	350	700	700	350	350
1951	280	210	---	---	35	350	140	---	140	70	420	210	350
1952	280	210	---	---	35	210	350	---	210	140	420	210	350
1953	---	---	---	---	63	140	49	---	210	140	420	210	350
1954	---	---	---	---	21	140	42	---	140	140	**	**	**
1955	---	---	---	---	21	*	56	---	140	140	---	---	---
1956	---	---	---	---	21	---	28	---	210	280	---	---	---
1957	---	---	---	---	21	---	56	---	210	70	---	---	---

The first two Plamt 4 processes were supposedly transferred to Plant 7 in 1952-3, the last two to Plant 6E in 1950-1. Compare to information for Plants 6E and Plant 7 (Table 9). Prior to 1946, the Plant 6 operations were done in Building 51 of Plant 2; all work was transferred to Weldon Spring in March 1957. Note that the figures above reflect chronologically the significant improvements in ventilation and dust control made in 1949.

* Discontinued

** Transferred to Plant 7 in October 1952

Table 9. Uranium dust concentrations, Plants 6E and 7, in alpha dpm/m^3 (Mason 1958a, Tables 3, 4).

	Plant 6E						Plant 7		
	KB-2 production			YM-5 production			All operations		
Year	Average	High	Source of high reading	Average	High	Source of high reading	Average	High	Source of high reading
1950	7	21	Charging	70	126	Crucible assembly	---	---	
1951	21	56	Residue	77	126	Top furnace	---	---	
1952	28	70	Residue	84	161	Burnout	35	112	UO_2 dumping
1953	21	84	Charging	35	49	Top furnace	28	119	Furnace operation, TA-7 packaging
1954	35	210	Residue	63	119	Bottom furnace	35	490	Sampling, cleanup
1955	112	280	Residue	42	105	Bottom furnace	21	77	UO_2 dumping
1956	28	112	Capping	35	42	Bottom furnace	28	56	UO_2 dumping
1957	28	105	Burnout	49	84	Bottom furnace	21	56	UO_2 dumping
1958	56	147	Breakout	84	147	Bottom furnace	35	98	TA-7 packaging

Plant 6: KB-2 is the derby form and YM-5 the billet form of uranium metal.
Plant 7: Operations were moved to Weldon Spring in 1958.

Table 10. Early air sample data, short-term sample readings in alpha dpm/m^3.

	1943		1944			1945			1946		
Location and operation	Value	No. of Samples	Value	GSD	No. of Samples	Value	GSD	No. of Samples	Value	GSD	No. of Samples
Plant 1											
Bldg K, Feinc filtration						60		2			
Bldg 25, Laboratory						7		2			
Plant 2 (Bldgs 51/51A)											
Oxide being added to Tank 1A	153	1									
Pot Room, general area	301	1	742		2	511		1			
Pot Room, aisle between pots						700		1			
Pot Room, (un)loading UO_3	2,000	1				2,380		1			
Pot Room, chipping, scooping cake	11,300	1									
Milling UO_3			2,800	3.03	3	3,220		1			
Sifting room general area	304	2									
Sifting room, sifting	22,50	1									
UO_2 being weighed	70	1									
UO_2 unloading			15,540		2						
UO_2 packaging			65,800		1						
Plant 2 (Shotgun Lab, Bldg 55)											
Shotgun residue evaporation			62		2						
Shotgun residue grinding			97	1.54	4						
Plant 4											
UF_4 general area						49		3			
Unloading UF_4			6,160		2	91		1	563	2.36	4
Milling UF_4			6,062		2	74		2	630		2
Mixing/blending/jolting UF_4, Mg			1,960		1				84		2
Bomb area general			5,320	1.22	3						
Bomb loading			2,100		1						
Bomb unloading			1,154	2.79	4				324		2
Biscuit chipping			4,484	1.27	3				42		1
Biscuit sealing			1,540		1						
Slag barreling			210	1.10	4						
Crucible burnout			2,100		1						
Recast furnace general area			976		2						
Recast furnace unloading			700		1						
Recast furnace brushing			980		1						
Ore milling						720	2.70	4			
Ore handling						1,230		2			
Plant 6											
Ore storage – area									246	4.08	9
Boxcar									504	4.10	3

The sampling data used to produce the table above are from MED (1943d; 1944b; 1944c; 1944d; 1944e; 1944g; 1944h; 1945d; 1946d; 1946e; MED 1945o) and MCW (1946b; 1946c; 1946d; 1946e; 1946f). The figure given in the Value column is the median, if there were three or more samples; the mean if there were two samples; and the sole value if there was one sample.

Table 11. Airborne uranium dust concentrations in Plant 4 Areas, 1948: AEC versus Mallinckrodt measured data (AEC 1949b, Table 3).

Activity	Multiple of "Preferred Level"		ug/m^3		Adjusted to dpm/m^3	
	AEC	Mallinckrodt	AEC	Mallinckrodt	AEC	Mallinckrodt
LF-9 Loading						
Operator A	47.7	29.7	2.39E+03	1.49E+03	3.34E+03	2.08E+03
Operator B	47.7	30.7	2.39E+03	1.54E+03	3.34E+03	2.15E+03
Furnace Tending						
Operator A	7.5	5.7	3.75E+02	2.85E+02	5.46E+02	3.99E+02
Operator B	9.1	6.1	4.55E+02	3.05E+02	6.37E+02	4.27E+02
TA-7 Unloading						
Operator A						
- Manual	186	66.8	9.30E+03	3.34E+03	1.30E+04	4.68E+03
- Semi-mechanized		16.4		8.20E+02		1.29E+03
Operator B						
- Manual	186	57.2	9.30E+03	2.86E+03	1.30E+04	4.00E+03
- Semi-mechanized		20.7		1.04E+03		1.45E+03
TA-7 Mixing & Packing						
Operator A	63	13.1	3.15E+03	6.55E+02	4.41E+03	9.17E+02
Operator B	57	24.6	2.85E+03	1.23E+03	3.99E+03	1.72E+03
Bomb Charging	51	42.4	2.55E+03	2.12E+03	3.57E+03	2.97E+03
Topping	10.4	32.4	5.20E+02	1.62E+03	7.28E+02	2.27E+03
Jolting	51	7.5	2.55E+03	3.75E+02	3.57E+03	5.25E+02
Charge Firing	13.3	13.8	6.65E+02	6.90E+02	9.31E+02	9.66E+02
Derby Unloading						
Operator A	5	9.1	2.50E+02	4.55E+02	3.50E+02	6.37E+02
Operator B	5	18.7	2.50E+02	9.35E+02	3.50E+02	1.31E+03
Chipping	26.3	11.5	1.32E+03	5.75E+02	1.84E+03	8.05E+02
Slag Handling	1.6	2.2	8.00E+01	1.10E+02	1.12E+02	1.54E+02
Top Furnace Tending						
Operator A	61	36.5	3.05E+03	1.83E+03	4.27E+03	2.56E+03
Operator B	61	23.2	3.05E+03	1.16E+03	4.27E+03	1.62E+03
Bottom Furnace Tending	73	59	3.65E+03	2.95E+03	5.11E+03	4.13E+03
Sawing	15.8	5.4	7.90E+02	2.70E+02	1.11E+03	3.78E+02
Cage Handling	2.7	52	1.35E+02	2.60E+03	1.89E+02	3.64E+03
Office	0.6	4.1	3.00E+01	2.05E+02	4.20E+01	2.87E+02
Shipping & Receiving	1.6	6.8	8.00E+01	3.40E+02	1.26E+02	4.76E+02
Mechanics	5	10.7	2.50E+02	5.35E+02	3.50E+02	7.49E+02
Carpenter	2	4.6	1.00E+02	2.30E+02	1.40E+02	3.22E+02
Porters	0.8	2.9	4.00E+01	1.45E+02	5.60E+01	2.03E+02
Guards	0.4	1.4	2.00E+01	7.00E+01	2.80E+01	9.80E+01

At the time of this report, AEC's "preferred level" for U dust in air, 50 µg/m^3, was based on an assumption of exposure 8 hrs/day, 6 days/week (AEC 1949b). Columns 2 and 3 are based on this.

Columns 4 and 5 represent the values in Columns 2 and 3 respectively multiplied by 50 µg/m^3.

Columns 6 and 7 represent the values obtain by multiplying Columns 4 and 5 respectively by 70 dpm/m^3 (assuming 70 dpm/m^3 is equivalent to 50 ug/m^3).

Table 12. Plant 4 measured daily weighted average exposure concentrations.

Occupation	Weighted average concentration, alpha dpm/m^3								
	5/1956	11/1953	3/1953	6/1950	10/1949	9/1948	5/1948	AEC 1949b	AEC 1951a
Magnesium operator				35	70				
Lime blender				35	70				
Slag man				70	105	210	140		
Cage man (handler)				190		3640	189	2940	
Derby unloader				175	245	1,260	280		
Bomb topper				210	280	2,310	840		
Charge firing				140	350	980	910		
Derby chipper				140	350	910	1,890		
Jolter				70	140	490	3,500		
Bomb charger				210	490	3,010	3,640		
Green lead man				70	140				
Cleanup man				140	140				
Furnace tender				70	70	350	560		
Furnace box puller				35	140	560	630		
TA-7 Pilot Plant				980	175				
Brown loader				280	350	2,240	3,360		
Green packer				245	210	1,750	3,990		7,210
Green miller and mixer				70	140	980	4,690		
Green unloader				210	490	1,540	13,020		
Plant superintendent	7.3								
Technical supervisor	6.6								
Engineers	7.3	9.8	14						
Chief chemist	5.9								
Vacuum fusion chemist	39								
Vacuum fusion technician	59								
Microscopist	18.4								
Chemist	10								
Chemical technician	10	4.6	7						
Foreman	22.5	6.7	12	35	70	175			
Shift foremen	12.4			56	98	175			
Lead operator	25	8.2	19	119	63	---			
Dingot/bomb, slag grinding oper	85	33	64	X	X	X		X	
Furnace and saw man	17.5			X	X	X		X	
Casting furnace operator	10.8	110	480					5110	
Furnace operator (UF_4-derby?)				91	70	570			
HF operator				91	70	570			
UO_3 & Brown packer				217	322	2,730		4200	2,730
Green packing operator				196	315	7,210		4,000; 13,000	
Asst green packing operator				112	133	2,800			
Residue	27.4								
Ceramic	14.8								
Vertical lathe	28.5								
Forge press lead operator	22								
Forge press salt bath man	21.5								
Forge press manipulator (oper)	22.6								
Forge press operator	21.9								
Clerk	5							42	
Guard	7.1							28	
Porter	40	2.7	5.8					56	
Area mechanic	---	22	15	84	112	350		350	

Data from the surveys of 6/50, 10/49, 9/48, and 5/48 is from AEC 1950c; data from the surveys of 3/53 and 11/53 is from AEC1954b; and data from the survey of 5/56 is from AEC 1956a. Other data are from the references given in the column headings.

Table 13. Plant 6 measured daily weighted average exposure concentrations.

Occupation	Weighted average concentration, alpha dpm/m^3								
	May 1956	May 1954	Oct 1953	Jan 1953	Jan 1952	Aug 1950	1949	Oct-Nov 1948	May 1948
Digest area lead operator	6	60	36	62	140	84		686	280
Digest operator	7.3	37	41	52	370	77		399	490
U-Con man #1	7.3								
U-Con man #2	14								
Feinc operator	6.2	96	38	110	175	154		980	840
Barium operator			38	130	144	126			280
Feed operator	40.8	23	100	150	110	126		910	476
C-3 wash filter operator		79	32	48	120	116		497	476
C-3 adjustments operator			22	420	120			497	476
C-3 centrifuge operator		42	630	52		140		567	476
Ore Room operator			140	170	370	392	350	13,720	4970
Extraction area lead operator	34	5.4	4						
Ether House operator	11					40		46	
Ether House lead operator						66		154	
Sump recovery operator			8.5	100	76	126		273	364
Raffinate operator	216	11	8	170	68	154		273	364
QM-2 (Orange) packager	268	1,961	120	130	130				
Furnace operator	12	33	55	96	150	1,400		5320	24500
Furnace room sampler								3150	
Reduction area (furn room) lead oper'r	22	25	28	69	54	147		686	
LF-9 (Brown) packager						364		11270	39200
Nitric acid recovery operator	20	9.6	19	44	35	99		46	364
Pot Room operator	234	113	45	190	100	336	770	7,770	32200
Metal dissolver #1	204								
Metal dissolver #2	21								
MGX operator		29	68	52	94				
Utility operator	88	129	94	97					
Miller (Mill Room)						X	X	12,600	46200
Pilot Plant group leader	7.5	6.9	3.1			105		91	245
Pilot Plant lead operator	7.7	8.8	6.1	77	116	105		91	245
Pilot Plant technician	1,940	9.2	6	77	116	105		91	245
Production superintendent	7.7	8.8	56	25					
Experimental continuous furnace						8,540	X	X	X
Asst. production superintendent	18	21	26						
General/Asst foreman	14	18	30	50					
Foreman	17	21	29	58				161	
Technical supervisor	18	21	25	33		52		161	
Production Office clerk	9.1	12	18	17		27		161	
Production Office secretary	3.4	3.4				27			
Shift foreman	19	25	27	81	96			161	
Cloth & Training Grp Lead Operator			23	25				2520	
Cloth operator		18	19	92		245		665	
Trainers						231		2,520	
Decontamination man	17	22	19	60	99				
Decontamination man	3.5	2.7	2.8	29					
Receiving clerk	5.2	19	4.5	10	99	28			
Cleanup man	22								
Production Research Lab personnel	3.7	2	5	13	30	12		30	245
Ledoux Lab asst technician (raffinate)	15.2	8.1	39						
Ledoux Lab technician (raffinate)	12.9	8.1	39	140	420	91		189	
Ledoux Lab technician (K-65)	21	7.5	27	440	1,900	1,400		2,100	
Ledoux Lab technician (MgF_2)	21	7.5	27						
Shotgun Lab analyst	24.1	10	27	23	25	239		24 (239)	
Laboratory personnel	42	2.9	30	23	21				
MCW Laboratory west section						21		30	245
MCW Laboratory east section						13		30	245
Powder sample technician	56.5					217?		448	
Metal room sampler	420								
Outside sampling man	22.5								
Sample Room supervisor	41					245		448	
Laboratory Office personnel	42	2	5.6						

Table 13 (Continued)

Occupation	Weighted average concentration, alpha dpm/m^3								
	May 1956	**May 1954**	**Oct 1953**	**Jan 1953**	**Jan 1952**	**Aug 1950**	**1949**	**Oct-Nov 1948**	**May 1948**
Truck operator	16	19	20	63	75				
Truck operator	20	19	20	63	75				
Warehouse foreman & Asst Foreman	4.2	2.9	6.2	17		70		161	
Warehouse man -- K-65 sampler			350	270	230	84		189	196
Warehouse man	5.8	10	20	38	46	84		189	196
Boiler House operator	9.3	7.3	7.5	8.9	2	36		44	
Laundry operator	6.2	19	11	19	4.5	13			
Porter	3.9	17	14			39			
General cleanup						39			
Change room						48			
Lunch room						5.6			
Clothes issue man	18	19	9.4	92					
Chief guard	1.7	14	16	14	1.8				
Security Office						6.3			
Guard	10	13	15	22	1.8	32			
Health Office - personnel (office)	1.6	6.7	15	14	0	11			
Health Office - personnel	8.1	11	15	14	0			7.0	14
Health Office personnel (plant monitor/health surveyor)	10	15	15	14	0	46			
Health Office person'l (plant monitor)	15	16	15	14	0				
Medic	1.3	3.5	6.3						
Nurse		3.5	6.3	42	99				
Dispensary & Safety						56		56	175
Instrument Shop technician	12	33	17	40	60	51			252
Instrument Shop machinist	5.5	44	17	27	60	51			252
Maintenance/mechanical supervisor	140	13	10	42	38	50			
Maintenance Office clerk	6.5	12	7.7	39					
Area mechanic	24	29	28						
Ore & Furnace Room AM						189			
Digest & feed AM						133			
Raffinate and C-3 AM						161			
Ether & NA House AM						77			
Welders, pipefitters, etc.						98		128	
Carpenters						66			
Stock Room (Storeroom) foreman	3.7	14	22	13	33	21			
Stock Room clerk	2.6	9	34	15	33	21			
AEC Office personnel		2.2	1.8	6.7	0	Non-det		7.7	33
AEC Engineer		19	9.9	31	7				
MCW Office personnel	1.5	2	2.9	0.7	0			7.0	50
MCW engineer	4.2	4.5	5.4	10	7	15			
MCW Office messenger	15	14	15	40					
MCW Office maintenance	7.5	12	20	10					
MCW Office construction expeditor			9.6	29					
Overall average weighted exposure	41	24	25	56	63				

Notes

The first set of 1948 data (Oct-Nov 1948) is from MCW (MCW 1949d (repeated in AEC 1949b and MCW 1950s), the second set (May 1948). The 1949 and 1950 data are from MCW (MCW 1950q) and AEC(AEC 1953); the May 1952, January 1953, and the October 1953 sets of survey data are from AEC (AEC 1954c); the May 1954 survey data are from AEC (AEC 1954d); and the May 1956 survey data are from AEC (AEC 1956b). For some occupations (mostly office types), the May 1948 concentration was the average in the work area, not a DWE, so that the level shown would be higher than what the worker actually experienced.

Table 14. Plant 6E measured daily weighted average exposure concentrations.

Occupation	Weighted average concentration, alpha dpm/m^3					
	7/1956	3/1955	6/1954	11/1953	4/1953	10/1952
Lime blender/Slag blender	5.7	11	13	8.9	19	8.9
Jolter	15	79	18	8.9	17	25
Utility operator	50	38	33	32	56	37
Top/Upper “F” machine operator	23	100	46	12	85	25
Bottom/Lower “F” machine operator	29	52	24	13	17	23
Top(ping)-off man	24	113	17	13	17	28
Reduction furnace operator	7.2	20	7.4	6.8	17	14
Breakout operator/man	23	42	28	23	42	25
Residue man	24	300	115	210	80	66
Reduction (KB-2) lead operator	21	36	26	24	36	45
Furnace loaders				23	16	15
Crucible loader	60	19	49	43	130	28
Burnout man	39	31	23	26	26	160
Crucible assembler	42	32	31	58	43	81
Upper/Top furnace operator/man	26	28	30	23	16	21
Bottom furnace operator/man	41	107	118	34	28	68
Saw operator/man	13	425	34	49	17	30
4th or cage saw man		38	21	66	94	17
Cage/cage grinding man	349	35	20	55	166	55
Billet grinder	668	425	34			
Brushing man		47				
Brushing man/chipper	19	2,110				
Recast furnace (YM-5) lead operator	71	30	47	21	19	49
Production machinist	7	11	7.5	10	17	380
Mechanic	73	36	23			
Millwright	14	36	23			
Maintenance man	27	36	23	53	26	45
Porter	15	23	12	19	8.8	42
Production clerk	9.5	14	7.8	18	13	13
Technical superintendent	4.4	24	15			
Technical/Chemical engineer	5.7	24	15	11	16	27
Shift foreman	12	31	23	17	17	44
Foreman/General foreman	6.1	27	19	12	13	20
Lift truck driver	8	22	17	14	15	30
Electrician		35	14	43	34	
Decontamination man	15	34	24	21	21	
Slag building operator	18	224	110			
Average of all personnel	44	113	30	33	43	55

The 10/52, 4/53, and 2/54 sets of data are from AEC (AEC 1954d); the 6/54 survey data are from AEC (AEC 1954e); the 3/55 survey data are from AEC (1955e); and the 7/56 survey data are from AEC (AEC 1956c).

Table 15. Plant 7 measured daily weighted average exposure concentrations.

	Weighted average concentration, alpha dpm/m^3						
Occupation	**7/1956**	**3/1955**	**6/1954**	**11/1953**	**4-5/1953**	**10/1952**	**9/1951**
Utility operator/man	17	18	23	77	14	28	9
Area mechanic	12	12	6	11	63	14	37
Welder	14	13	7	10	14	14	
Porter	32	25	13	6	14	14	
Lift truck operator/driver	41	26	14	6	14	14	
HF operator	5.3	5	5	4	14	14	8
TA-7 hoisting operator	17	11	13	11	14	14	
Furnace operator	14	16	10	120	14	21	25
Sampler and cleanup man	9.1	8	8	530	42	28	
36' Level operator	19	6	5	20	14	14	
Panel board operator	16	30	16	7	21	21	
TA-7 packager	24	49	68	150	56	28	242
QM-2 dumper/hoister	56	74	48	42	63	112	107
Magnesium Room operator	4.5						
Foreman	15	16	7	6	14	21	28
Assistant foreman					8	21	22
Asst plant superintendent	32	70	7				
Technical supervisor	18	15	6				
Engineer		70	7	13	7	14	
Lead operator	30	17	9	12	14	21	38
Clerk/Record clerk	20	32	8	6	14	21	
Decontamination/-ator	18	17	9	10	14	21	
Safety inspector		9	12	16	28		
Fire marshal		9	12	16			
Safety clerk		14	9	17			
Average for all personnel	19	19	13	57	22	21	

The 9/51 survey data are from AEC (AEC 1951a); the 10/52 survey data are from AEC (AEC 1952a); the 4-5/53 and 11/53 survey data are from AEC (AEC 1954f); the 6/54 survey data are from AEC (AEC 1954g); the 3/55 survey data are from AEC (AEC 1955d); and the 7/56 survey data are from AEC (AEC 1956d).

The 5/53 data includes the screw-pulling operation, which was nonroutine.

Table 16. Plant 7E measured daily weighted average exposure concentrations.

Occupation	**Weighted average concentration, alpha dpm/m^3, 3/1955**
Ionium plant operator	0.06
Ionium plant lead operator	0.1
Overall average	0.07

Survey data are from AEC (1955e). The ionium plant was the thorium processing plant, in operation from mid-1955 through March 1957. Some bench-scale processing was done in the spring of 1955 also.

Table 17. Average and highest airborne dust concentrations in the laundry (alpha dpm/m^3) (Utnage 1958b, Table 2).

	Concentration	
	Average	**Worst**
Operation		
Load washer with coveralls	560	820
Load dryer with coveralls	50	140
Unload dryer with coveralls	20	70
Press white coveralls	40	55
Repair white coveralls	60	90
Sorting to wash	20	870
Weighted average by job		
Washer operator	50	
Presser	40	
Repairman	40	
Sorting and handling	30	140
Average general air in laundry	20	110

"Worst" measurements for sorting and handling were taken with no ventilation; "Worst" measurements for the general air case were taken with ventilation turned off for 4 hours.

"Average" measurements were taken with ventilation on. The worst "average" air in the general area case was found in the vicinity of handling and loading into the washer.

Table 18. Job titles and classifications, with geometry factors.

Plant	Job title or classification	Notes	Geometry classification, %		
			AP	ROT	ISO
7	36' Level operator	Subclassification of 7 Furnace operator (rotating jobs): mainly the UO_2-to-UF_4 reactor area	---	---	---
6E	4th saw man	Mostly same as Saw man	90	10	
6	AEC engineer	Spent time in Plants 4, 6, 6E, and 7 but office was in 6	10	90	
6	AEC Office personnel	Spent time only in AEC office in Plant 6		100	
All	Area mechanic	May have worked in all buildings, but appears that he was usually dedicated to one building or process step	50	50	
6E	Asst foreman	See Shift foreman	50	50	
7	Asst plant superintendent	May have been in charge of only Plant 7 or of the whole site	10	90	
6	Asst production superintendent	Assumed to have spent time in Plants 6, 6E, and 7 production areas as well as Plant 6 offices, as the production superintendent did	50	50	
6	Asst warehouse foreman	Worked in the U products warehouse, apparently	25	75	
6	Bag inspector	Checked dust collector bags	75	25	
6	Barium operator	Worked in the barium salt addition phase of digestion	50	25	25
6E	Billet grinder	Cleaned and finished billets after recasting and before shipping	90	10	
4, 6E	Blender	See Lime blender	50	50	
6	Boiler House operator	Presumably worked to provide steam for the boildown processes		100	
4	Bomb charger	Blended UF_4, Mg; charged bomb; dumped out dust collectors	75	25	
4	Bomb makeup operator	Blended UF_4, Mg; charged bomb; dumped out dust collectors	75	25	
4	Bomb makeup/deslagging (slag grinding) operator	Performed combined functions of Bomb makeup operator and Slag grinding operator	75	25	
6E	Bottom "F" machine operator	Charged bomb (using F machine): UF_4-Mg mixture, Mg	75		25
4, 6E	Bottom furnace operator/man	Removed assembly from recast furnace, removed mold, put in new assembly	75	25	
6E	Breakout operator/man	Removed (broke out) derby from bomb	75	25	
6	Brown furnace operator/ unloader/ packager	See UO_2 operator/unloader/packager	75	25	
6E	Brushing man	Same as Chipper	75	25	
6E	Burnout man	Removed broken crucible, knocking lid off	80	20	
6	C-3 adjustments operator	Cleaned wash precipitate filter press; other duties	50	25	25
6	C-3 centrifuge operator	Operated and "plowed off" Bird(?) centrifuge (digestion process)	50	25	25
6	C-3 wash filter operator	Operated and cleaned the wash precipitate filter press	50	25	25
6E	Cage grinding man	Mostly same as Saw man	90	10	
4, 6E	Cage operator/man	Cleaned and finished billets after recasting; handled scrap in cage	90	10	
6E	Cage saw man	Mostly same as Saw man	90	10	
6E	Capping man	Put the valved top on the Mg-UF4 drum for jolting?	75	25	
4	Carpenter	May have worked in all buildings, not dedicated to one	25	50	25
4	Casting operator/man	Operated the billet casting furnace	75	25	
6	C. Eng	See Chemical engineer	25	75	
4	Ceramic (technician?)	Split time: ceramic lab (Ceramic Pilot Plant), Production Research Lab	50	50	
4	Charger	Same as Bomb charger	75	25	
4	Charge firing (man)	Furnace operator for bomb furnace	75	25	
6E	Chemical engineer	Worked in production aspects; had production area access	25	75	
4	Chemical technician	Did chemical analyses in Analytical Lab; possibly some assays	90	10	
4	Chemist	Did chemical analyses in Analytical Lab; possibly some assays	90	10	
4	Chief chemist	Did chemical analyses in Analytical Lab; possibly some assays	90	10	
6	Chief guard	Spent time in Plants 4, 6, 6E, and 7 but base was in Plant 6		100	
4, 6E	Chipper	Deslagged and cleaned derbies (and dingots?)	75	25	
4, 6	Cleanup man	Miscellaneous cleanup activities	50	50	
4, 6E, 7	Clerk	Plant 7 clerk worked in Plant 6E as well as inventorying in the Plant 7 production area; Plant 4 clerk may have been same person(s)		100	
6	Cloth operator/man	Cut and replaced filter cloth for Feinc and similar filters	50	25	25
6	Cloth & Training Group lead operator	Apparently dual position: coordinated cloth ops, headed Training Grp	10	90	
6	Clothes issue man	Issued work and protective clothing in the locker rooms		100	
6E	Crucible assembler	Assembled crucible and mold assembly in billet production process	75		25
6E	Crucible loader	Loaded the crucible assembly into the recast furnace	75		25
6,6E,7	Decontamination man	Did decontamination in all plants, on boxcars, in Plant 6 Decon Room	50	25	25
7	Decontaminator	Same as Decontamination man	50	25	25
6E	Derby chipper	Same as Chipper	75	25	
4	Derby unloader	Unloaded bomb from furnace	75	25	
6	Digest area lead operator	Worked on the digestion process (up to extraction)	50	25	25
6	Digest operator	Worked on the digestion process (up to extraction)	50	25	25

Table 18 (Continued)

Plant	Job title or classification	Notes	Geometry classification, %		
			AP	ROT	ISO
4	Dingot operator/forging	Prepared, loaded, removed dingot bomb; probably operated furnace	50	25	25
6	Dispensary (personnel)	Medical-pharmaceutical personnel; no prod area access assumed		100	
6E	Electrician	May have worked in all buildings, not dedicated to one	25	50	25
4, 6E, 7	Engineer	Assumed to be the process engineer assigned to individual plant; may have worked in all; had production area access	25	75	
6	Ether House operator	Worked in the ether house (operating tanks, valves, etc.)	50	50	
6	Experimental Continuous Furnace	Pilot Plant project for eventual plant-scale use in Plant 7	25	50	25
6	Extraction area lead operator	Worked on the extraction process (up through UO3 production?)	50	25	25
6E	Extra man	Presumably a "floating" worker (cf. Utility man)	50	50	
6E	F (machine) charger	Loaded Mg, UF_4 into bomb and sealed it; may have blended them	75		25
6E	F machine operator	Charged bomb (using F machine): UF_4-Mg mixture, Mg	75		25
6	Feed operator	Loaded black oxide and other feeds for digestion; washed out feed Niagara; may have handled other aspects of the ore-to-UO_3 process	50	25	25
6	Feed sampling	Sampling of feed (soda sat, MGX, etc.)	50	25	25
6	Feinc operator	Operated Feinc filter; cleaned out cake; washed out feed Niagara	50	25	25
7	Filter operator	Operated solids-removal(?) filters in Slag Separation Plant (Bldg 701)	50	50	
7	Fire Marshall	Did inspections in Plants 4, 6, 6E, and 7, but base was in Plant 6		90	10
All	Foreman	Apparently dedicated to individual plant, but may have worked in more	50	50	
4	Forge press lead operator	Operated the forge press in dingot finishing	75		25
4	Forge press manipulator	Same as Forge press operator	75		25
4	Forge press operator	Operated the forge press in dingot finishing	75		25
4	Forge press salt bath man	Operated the salt bath segment of dingot finishing	75	25	
All	Fork truck operator/driver	Same as lift truck driver; some did work at SLAPS and with railcars	25	75	
4	Furnace and saw man	Divided duties: see Furnace operator and Saw man	75	25	
4, 6E	Furnace loader	Loaded bomb or crucible assembly into furnace, depending on plant	75		25
4, 6E	Furnace operator	Operated recasting (billet) furnace	75		25
6	Furnace operator	Operated the UO3-to-UO2 (Rockwell) furnace	75	25	
7	Furnace operator	Job (Plant 7) rotated 36' Level, Panel Board, and Sampler & Cleanup tasks: see individual job titles	75	10	15
4	Furnace puller	Unloaded UO_2-to-UF_4 furnace?	75	10	15
4	Furnace tender	Tended UO_2-to-UF_4 furnace	75		25
6E	Furnace unloader	Unloaded bombs from furnace, cleaned out residue(?)	75		25
6, 6E, 7	General foreman	UF_4 production (for Plant 6E); or may have spent time in all plants	50	50	
6E	Graphite shop personnel	Assumed to be doing only clean work manufacturing graphite molds		100	
7	Green packager	Packaged UF_4 (green salt)	75	25	
4	Grinding and lead operator	Apparently work in the dingot area	50	25	25
All	Guard	Spent time in Plants 4, 6, 6E, and 7 and SLAPS but base was in 6		75	25
6	Health Office - office personnet	Assumed to spend all time in Health Office		100	
6	Health Office - other personnel	Spent time in Plants 4, 6, 6E, and 7 but base in 6; assume no production area access		100	
6	Health Office - plant monitor	Spent time in Plants 4, 6, 6E, 7 but base in 6; production area access	50	50	
6	Health Office - health surveyor	Spent time in Plants 4, 6, 6E, 7 but base in 6; production area access	50	50	
4, 7	HF operator	Spent some time at Bird centrifuge (7), in recovery areas (7), as well as in providing HF for the hydrofluorination process (UO_2-to-UF_4)(4,7)	10	90	
7	Hoisting (slag) operator	Worked in the Slag Separation Plant (Bldg 701)	50		50
6	Instrument Shop machinist	Worked only in Instrument Shop; some equipment contaminated	10	90	
6	Instrument Shop technician	Spent time in Plants 4, 6, 6E and 7 but base in 6 (Instrument Shop); production area access	25	75	
7E	Ionium plant lead operator	Th-230 processing (mostly operating chemical tanks and filters)	75	25	
7E	Ionium plant operator	Th-230 processing (mostly operating chemical tanks and filters)	75	25	
4, 6E	Jolter	"Jolted" (air hammer?) bomb liner, other material to compress, remove	75	25	
6	K-65 sampler	See Warehouse man: K-65 sampler	90	10	
4, 6E	KB-2 lead operator	Handled all aspects of derby (KB-2 production)	75	15	10
6	Laboratory Office personnel	Worked in the Analytical Lab (Building 102)		100	
6	Laboratory personnel	Worked in the Analytical Lab (Building 102)	90	10	
6	Laundry lead operator	Handled operations at the laundry (incl contaminated items)	10	90	
6	Laundry operator	Laundered work and protective clothing (incl contaminated items)	10	90	
4, 6, 6E 7	Lead Operator	Generic: see specific titles; otherwise, (default) geometry factors at right may be used	75	25	
6	Ledoux Lab asst tech (raff)	Worked in the Ledoux Lab pulverizing, prepping, assaying raffinate	90	10	

Table 18 (Continued)

Plant	Job title or classification	Notes	Geometry classification, %		
			AP	ROT	ISO
6	Ledoux Lab technician (raff)	Worked in the Ledoux Lab pulverizing, prepping, assaying raffinate	90	10	
6	Ledoux Lab technician (K-65)	Worked in the Ledoux Lab assaying K-65 residue	90	10	
6	Ledoux Lab technician (MgF_2)	Worked in the Ledoux Lab assaying MgF_2, incl recycle MgF_2	90	10	
4	LF-9 (furnace) loader	See Furnace loader, Furnace operator for Plant 4 (UO_2-to-UF_4)	75	25	
6	LF-9 unloader/packager	See UO_2 operator/unloader/packager	75	25	
6E, 7	Lift truck driver (operator)	Drove lift truck, handling miscellaneous materials, possibly at all plants, including SLAPS	25	75	
4, 6E	Lime blender	Charge blender for derby production	50	50	
4	Magnesium operator	Handled magnesium storage and disbursal; limited exposure potential?	75	25	
7	Magnesium Room operator	Handled magnesium storage and disbursal; limited exposure potential?		100	
6E	Maintenance man	May have worked in all buildings; assume production area access	50	50	
6	Maintenance Office clerk	Worked only in Maintenance Office		100	
6	Maintenance supervisor	Spent time in Plants 4, 6, 6E and 7 but base was in 6 (same person?)	25	75	
	Manufacturing	Generic term for process/storage area work	75	25	
4, 7W	Metal fab	Metal fabrication, i.e., the derby and recast or dingot areas	50	50	
6	MCW engineer	Spent time in Plants 4, 6, 6E and 7 but base was in 6	10	90	
6	MCW Lab (personnel)	This lab was not the Ledoux, Shotgun, or Research Labs, which were listed separately in the records; perhaps the Analytical Lab	25	75	
6	MCW Office construction expeditor	Spent time in Plants 4, 6, 6E, and 7, but probably only in office and construction areas		100	
6	MCW Office maintenance	Spent time in Plants 4, 6, 6E, and 7, but apparently only in office areas		100	
6	MCW Office messenger	Spent time in Plants 4, 6, 6E, and 7, but probably only in office areas		100	
6	MCW Office personnel	Spent time only in MCW offices in Plant 6 (Bldg 112?)		100	
All	Mechanic	See Area mechanic	50	50	
6	Mechanic supervisor	See Maintenance supervisor	50	50	
6	Medic	Worked in dispensary presumably, but may have gone into production areas on occasion		100	
6	Metal dissolver (#1, #2)	Dissolved scrap U metal in acid for recycling as feed? Also spent up to half time in Pot Room	75	25	
6	Metal room sampler	Sampled scrap and other metal for U or content?	75	25	
6	MgX operator	Processed the MgX feed material	25	50	25
4	Microscopist	Worked full-time in the Microscopy Room, probably on U specimens		100	
4, 6	Miller	Performed the UF4 pulverizing (4)? Milled UO_3 (orange oxide)(6)	50	50	
6E	Millwright	May have worked in all buildings, not dedicated to one	25	50	25
6	Nitric acid recovery operator	Worked in the nitric acid recovery area (several buildings)	50	25	25
6	Nurse	Worked in dispensary presumably, but may have gone into production areas on occasion		100	
4, 6E	Office employees	Assume they are Plants 4 and 6E production(?) office-only personnel		100	
6	Ore Room operator	Handled ore, residue: storage, lidding, delidding, cleaning drums	70	20	10
6	Outside sampling man	Sampled dust collectors; sampled drums (incl. opening and sealing)	50	50	
7	Panel board operator	Subclassification of 7 Furnace operator (rotating jobs): vacuuming C-3 into reverter, sampling D-30 material, replacing D-30 drums, work at panel board area including reverter operation	---	---	---
6	Pickler	Worker in area where derbies were “pickled”, i.e., put into acid bath	75	25	
6	Pilot Plant engineer	Participated in experimental extraction processes and like activities	25	75	
6	Pilot Plant group leader	Participated in experimental extraction processes and like activities	75	25	
6	Pilot Plant lead operator	Participated in experimental extraction processes and like activities	75	25	
6	Pilot Plant technician	Unclear what activities this Pilot Plant was carrying on	75	25	
6	Pipefitter	May have worked in all buildings, not dedicated to one	50		50
4	Plant superintendent	May have been in charge of only Plant 4 or of the whole site	10	90	
4, 6, 6E, 7	Porter	Some porters may have worked in a janitorial capacity, entering only office areas, while others apparently served production areas; may have worked in several plants or in only one		100	
6	Pot Room operator	Worked in the denitration (UO_2-to-UF_4) pot room	50	25	25
6	Powder sample technician	Assume mainly did sampling and worked with small samples	75	25	
6E	Production clerk	Kept records, did inventories; assumed to spend some time in production area		100	
6E	Production machinist	Spent all time in graphite shop machining molds and the like		100	
6	Production Office clerk	Kept records, did inventories; assumed to spend some time in production area		100	
6	Production Office secretary	Assumed spent all time in office		100	
6	Prod Research Lab personnel	Worked in the Production Research Lab	90	10	
6	Production superintendent	Spent time in Plants 6, 6E, and 7 production areas and Plant 6 offices	50	50	
7	QM-2 dumper	Loaded UO_3 into trays for the UO_3-to-UF_4 conversion	75	15	10

Table 18 (Continued)

Plant	Job title or classification	Notes	Geometry classification, %		
			AP	ROT	ISO
7	QM-2 hoister	Same as QM-2 dumper	75	15	10
6	QM-2 loader	See UO_3 loader	75	25	
6	QM-2 (orange) packager	"Gulped" (vacuum-extracted) UO_3 out of the pot and into drums; weighing and making up (weight) in drums, emptying dust collectors	75	15	10
6	Raffinate operator	Handled the various residues from the filters (drummed, sampled); spent up to half time in Pot Room	75	25	
6E	Recast furnace lead operator	Operated the billet casting furnace	50		50
6	Receiving clerk	Recorded and inventoried incoming shipments of ore and U products	50	50	
7	Record clerk (A, B)	Kept records of receipts, production, and shipments; some entry into production areas and outside areas for inventory and like purposes		100	
6	Reduction (area) lead operator	Operated UO_2 (Rockwell) furnace; assumed to load UO_3, unload UO_2	75	25	
6E	Reduction (area) lead operator	Operated the bomb (UF_4-to-U metal) furnace	50	25	25
6E	Reduction furnace operator	Operated the bomb (UF_4-to-U metal) furnace	50	25	25
4,6E	Residue man	Changed derby chip drums and Hoffman and Mikro dust collectors; cleaned residue from the plate and frame press; picked out KB-2	75		25
7	Safety clerk	Worked full-time in the Safety Office		100	
7	Safety inspector	Did inspections in Plants 4, 6, 6E, and 7 (production area access)	10	80	10
4	Salt bath man	Same as Forge press salt bath man	75	25	
7	Sampler and cleanup man	Subclassification of 7 Furnace operator (rotating jobs): sampling UF_4, cleanup of furnace platforms	---	---	---
6	Sample Room supervisor	Supervisor operations in the Sample Room (probably in Bldg 111)	75	25	
4,6E	Saw operator/man	Removed billet from quench tank; ground, sawed, and weighed it	90	10	
6	Security office (personnel)	Assumed to be other than guards (e.g., clerical)		100	
6,6E	Shift foreman	Assumed to be generic, although may have covered several plants; default geometry factors at right may be used	50	50	
4	Shipping & Receiving (personnel)	Handled the receipt and shipment of U products	50	50	
6	Shotgun Lab analyst	Worked in Shotgun (sample assay) Lab, first in Bldg 55 in Plant 2, then Bldg 108 in Plant 6, then Bldg 102(?) of Plant 6	90	10	
6E	Slag blender	Blended C-liner and other slag from Plants 4 and 6 for use in bombs	75	25	
6E	Slag building operator	Ground C-liner and other slag, sorted it via shaker tables, drummed it	75	25	
4	Slag man, slag grinding operator	Mostly the same as Chipper	75	25	
6	Soluble feed operator	Loaded soda salt ("diuranate") at appropriate point in digestion process; see also Feed operator	75		25
6	Stockroom clerk	Stockroom possibly in Bldg 112. Spent time in Receiving (Bldg 101)		100	
6	Stockroom foreman	Stockroom possibly in Bldg 112. Spent time in Receiving (Bldg 101)		100	
6	Sump recovery operator	Worked on U recovery from sump fluids	25	50	25
6E	Supervisor	Probably same as Technical supervisor	50	50	
7	TA-7 hoisting operator (hoister)	Hoisted and loaded UO2 into reactor for conversion to UF_4 (TA-7)	25	50	25
4,7	TA-7 packager	Packaged UF_4 (green salt)	75	25	
4	TA-7 Pilot Plant (personnel)	Assumed to be technicians and operators producing UF_4 (green salt)	50	50	
4	TA-7 unloader (operator)	Unloaded UF_4 (green salt) from hydrofluorination reactor	50	50	
7	Tables operator	Worked in the Slag Separation Plant (701) operating shaker tables	25	75	
6E	Technical engineer	Same as Chemical engineer or (Process) Engineer	25	75	
6E	Technical superintendent	May have spent time in all the plants	25	75	
All?	Technical supervisor	Unclear what duties were; probable frequent production area access	50	50	
	Tinner	Type of metal worker	25	50	25
4	Top cleaner	Cleaned top furnace in billet (YM-5) production; not Top seat man	75	25	
6E	Top "F" machine operator	Charged bomb (using F machine): UF_4-Mg mixture, Mg	75		25
6E	Top furnace operator/man	Operated recasting (billet) furnace, removed crucible parts	50		50
6E	Top-off operator/man	"Topped off" bomb with slag, bolted on lid	75	25	
4	Topper	Same as Top-off operator?	75	25	
4	Top seat man	Involved in billet production, furnace area; same as Top-off operator?	75	25	
6	Trainer	Duties not clear. Assumed to train operators, especially in filter work	10	90	
6	Trainman	Associated with /oacing/unloading of railcars; perhaps was railcar dispatcher/coordinator/inspector; associated with the warehouse	25	50	10
6	Truck operator/driver	Spent time in Plants 6, 6E, and 7 areas; radiation most likely from the back in hauling, the front in loading: * 50 AP, 25 PA, 25 ROT	*		
6	UO_2 (furnace) operator	Operated the UO_3-to-UO_2 (Rockwell) furnace	75	25	
6	UO_2 unloader/packager	Unloaded UO_2 from the Rockwell furnace, packaged it	75	25	
4	UO_3 & brown packer	Loaded UO_2 into Rockwell furnace; unclear regarding UO_2	75	25	

Table 18 (Continued)

Plant	Job title or classification	Notes	Geometry classification, %		
			AP	ROT	ISO
6	UO_3 loader	Loader UO_3 onto trays and into the Rockwell furnace (may have been collateral duty of the UO_2 furnace operator)	75	25	
6E	Upper furnace man	Same as top furnace man	50		50
6	U-con man (#1, #2)	Handled U-containing slurry from Slag Sep Plant that went to Plant 6	50	25	25
7	Utility operator/man	Worked on various production jobs	50	25	25
6,6E	Utility operator	Average of all production jobs for the respective plant	75	25	
4	Vacuum fusion chemist	Worked in office and vacuum fusion area; did some hands-on U work	90	10	
4	Vacuum fusion technician	Worked in office and vacuum fusion area; did some hands-on U work	90	10	
4	Vertical lathe (operator)	Scalped dingot after casting and before forge-pressing	75		25
6	Warehouse foreman	Handled storage of ore and U products	25	75	
6	Warehouse man: K-65 sampler	New job, 1953: sampled K-65 residue, plus typical warehouse duties	90	10	
6	Warehouse man (other)	Handled storage of ore and U products	25	75	
6	Weighmaster	Duties not clear. Assumed to perform or approve ore, K-65 weighings	25	75	
6,7	Welder	May have worked in all buildings, not dedicated to one	10	90	
6E	YM-5 lead operator	Worked on billet (YM-5) casting	80	20	

Since these classifications are mostly based on later records (after the UO_3-to-UF_4 direct process was established at Plant 7), UO_2 (brown oxide, LF-9) unloading and packaging classifications and UO_3 (orange oxide, QM-2) milling and loading classifications have been added for Plant 6.

Table 19. Uranium dust daily weighted average exposure levels, Plant 4.

Job title	Airborne dust exposures, alpha dpm/m^3								
	Oct 1942 - 1946	1947	1948 - 1949	1950	1951	1952 - 1953	1954 - 1955	1956-1958	1957-1958
Mechanic/Area mechanic	350	350	350	84	15	15	22	22	X
Blender/Bomb charger/ Charger/Bomb makeup/ Dingot operator/Slag grinding operator	3,010	3,010	3,010	210	64	64	33	85	X
Cage operator/man	3640	3640	3640	190	X	X	X	X	X
Carpenter/Other craft	140	140	140	84	15	15	22	22	X
Casting operator/Furnace operator/Top seat man	5,100	910	980	140	480	480	110	11	X
Lab: ceramics/microscopy	X?	X?	X?	X?	18	18	18	18	X
Charge firing (man)	931	910	980	140	X	X	X	X	X
Chemist/Chief chemist/Chemical technician	40	40	40	40	7	7	10	10	X
Chipper/Cleanup man/Saw operator/man	1,890	1,890	910	140	140	140	140	140	140
Derby unloader	350	280	1,260	175	X	X	X	X	X
Foreman/Shift foreman/Engineer/Technical supervisor	175	175	175	56	12	12	10	23	X
Forge press operator/lead operator/manipulator*	X	X	X	X	X	23	23	23	X
Furnace and saw man	X	X	X	X	18	18	18	18	X
Furnace loader (UF_4-derby)	3,360	3,360	2,240	280	X	X	X	X	X
Furnace tender	560	560	350	70	X	X	X	X	X
Guard/Chief guard	28	28	28	28	28	5.8	2.7	7.1	X
HF (fluorination) operator	570	570	570	70	X	X	X	X	X
Jolter	3,500	3,500	490	70	X	X	X	X	X
KB-2/YM-5/Dingot lead operator/Furnace puller	931	630	560	35	19	19	8.2	19	X
UO_2/LF-9 loader/packer	4,200	3,360	2,240	280	X	X	X	X	X
Lime blender/Magnesium operator	70	70	70	35	X	X	X	X	X
Miller-mixer (UF4/TA-7)/Top cleaner	4,690	4,690	980	70	X	X	X	X	X
Office: Plant superintendent/Clerk/Other	42	42	42	42	42	5.8	2.7	7.3	X
Porter	112	112	112	56	56	5.8	2.7	40	X
Residue man/Salt bath man/Vertical lathe operator	X	X	X	X	X	X	28	28	X
Shipping & Receiving	126	126	126	126	15	15	22	22	X
Slag man/Slag grinding operator	140	140	210	70	X	X	X	X	X
TA-7 packager	7,210	7,210	7,210	245	X	X	X	X	X
TA-7 unloader (operator)	13,000	13,000	1,540	210	X	X	X	X	X
Topper	840	840	2,310	210	X	X	X	X	X
Vacuum fusion*: chemist/technician	X?	X?	X?	X?	X?	59	59	59	X

This table is derived from the data given in Table 12 and from supplementary information in the references.

An "X" indicates that the job title did not exist during the indicated period. An "X?" indicates that it is uncertain if the job title existed, i.e., it is not certain when that job began.

* Work started in 1953.

Table 20. Uranium dust daily weighted average exposure levels, Plant 6.

Job title	Airborne dust exposures, alpha dpm/m3							
	1946 - 1948	1949	1950	1951	1952	1953	1954	1955 - 1958
AEC engineer	X?	X?	X?	7	31	9.9	19	19
Barium operator	1.8	1.8	126	144	130	38	X	X
C-3 centrifuge/wash filter/adjustments operator	567	567	140	140	420	630	79	79
Cleanup man/utility operator	X	X	X?	97	97	94	129	88
Cloth operator	665	665	245	245	92	19	18	18
Cloth & Training Group lead operator/trainer	2,520	2,520	231	231	23	25	18	18
Clothes issue man	92	92	92	92	92	9.4	19	18
Crafts: Carpenter/Pipefitter/Welder	126	126	98	28	28	28	29	24
Decontamination man/U-Con man*	99	99	99	99	60	19	22	17
Cloth/Digest/Reduction operator, Outside sampling*	686	686	245	370	92	41	60	22
Dispensary: Nurse/Medic/Other (personnel)	175	175	56	99	42	6.3	3.5	1.3
Boiler/Ether House/Extraction /Nitric acid recovery operator	46	46	99	50	44	19	11	34
"Experimental Continuous Furnace": Pilot Plant project**	X?	8,540	8,540	X?	X	X	X	X
Feinc/Feed/Soluble feed operator	980	980	154	175	150	100	96	41
Foreman/General foreman/Shift foreman/Technical supervisor	161	161	161	96	81	30	25	19
Furnace operator	24,780	24,780	1,400	150	96	55	33	12
Guard/Chief guard	32	32	32	1.8	22	16	14	10
Health/Security Office personnel; Engineer (MCW, chemical)	15	15	15	7	14	15	11	8.1
Health Office: health surveyor/plant monitor	46	46	46	42	14	15	16	15
Instrument Shop machinist/technician	252	252	51	60	40	17	44	12
Laboratory Office personnel	100	100	10	5.6	5.6	5.6	2	42
Laboratory personnel - generic/MCW/Shotgun	245	245	24	25	23	30	10	42
Laundry operator/lead operator	X?	X?	X?	4.5	19	11	19	6.2
Ledoux Lab technician/assisstant technician - raffinate, MgF_2	189	189	91	420	140	39	8.1	27
Ledoux Lab technician (K-65)	2,100	2,100	1,400	1,900	440	27	7.5	21
LF-9/brown/UO_2 packager/unloader	38,990	38,990	364	350	350	X	X	X
Maintenance supervisor	50	50	50	38	42	10	13	140
Mechanic/Area mechanic: ore & furnace room, digest & feed, raffinate & C-3, Ether House, Nitric Acid House	189	189	2.7	28	28	28	29	24
Metal dissolver (#1, #2)	X?	X?	X?	204	204	204	204	204
Metal room sampler	X?	X?	X?	420	420	420	420	420
MgX operator	94	94	94	94	52	68	29	29
Miller (UO_3/QM-2)***	12,600	12,600	X	X	X	X	X	X
Office: MCW - Clerk/Maintenance/Messenger/Porter/ Expeditor	50	50	50	48	48	20	17	15
Office: MCW - Other, AEC - all AEC except Engineer	50	50	50	0	6.7	2.9	2.2	2.2
Office: Production - Clerk/Secretary, Receiving - Clerk	161	161	52	99	17	18	19	9.1
Ore Room operator***	13,720	350	392	370	170	140	140	X
Pilot Plant engineer	123	123	53	58	39	3.1	6.9	7.5
Pilot Plant lead operator/group leader	245	245	105	116	77	6.1	8.8	7.7
Pilot Plant technician	245	245	105	116	77	6	9.2	1,940
Pot Room operator	7770	770	336	100	190	45	113	234
Powder sample technician	3150	3150	217	217	57	57	57	57
Prod Research Lab personnel	84	84	12	30	13	5	2	3.7
Production superintendent/Asst production superintendent	25	25	25	25	26	56	21	18
QM-2 (orange) loader	5,320	5,320	1,400	420	420	420	X	X
QM-2 (orange) packager	1,400	1,400	1,400	420	130	130	120	*****
Raffinate/Sump recovery operator	273	273	154	76	170	8.5	11	216
Sample Room supervisor	448	448	245	245	245	41	41	41
Stockroom foreman/clerk	21	21	21	33	15	34	14	3.7
Truck/forktruck operator/driver	75	75	75	75	63	20	19	20
Warehouse foreman/Assistant foreman/Warehouseman	196	196	84	70	38	20	10	5.8
Warehouse K-65 sampler/Weighmaster****	196	196	84	230	270	350	350	X?

This table is derived from the data given in Table 13 and from supplementary information in the references.

An "X" indicates that the job title did not exist during the indicated period. An "X?" indicates that it is uncertain if the job title existed, i.e., it is not certain when that job began.

* Outside sampling and U-Con positions began in 1955
** Pilot Plant work began in 1948.
*** Milling work ended by June 1949.
**** These jobs apparently ended in 1954 or were subsumed in other job titles
***** 1961 dpm/m3 in 1955, 268 in 1956-58

Table 21. Uranium dust daily weighted average exposure levels, Plant 6E.

Job Title	Airborne dust exposures, alpha dpm/m^3				
	Oct 1950 - Dec 1952	1953	1954	1955	1956 -1958
Area mechanic	23	23	23	36	73
Billet grinder	34	34	34	425	668
Blender; Lime/slag blender	8.9	14	13	11	5.7
Bottom/Lower “F” machine operator	23	15	24	52	29
Breakout operator/man	25	33	28	42	23
Brushing man	X	X	X	47	47
Burnout man	160	26	23	31	39
Cage grinding/cage operator/man	55	111	20	35	349
Cage/4th saw man	17	80	21	38	38
Capping man/Crucible assembler	81	51	31	32	42
Chipper/Derby chipper	2,110	2110	2,110	2,110	19
Crafts: Maintenance/Electrician/Mechanic/Millwright; Graphite Shop	45	40	23	36	73
Crucible loader	28	87	49	19	60
Engineer/Chemical engineer/Technical engineer; Superintendent/Supervisor	27	14	15	24	5.7
F (machine) charger/Extra man/Utility operator	37	44	33	38	50
Foreman/Assistant foreman/General foreman	20	13	19	27	6.1
Furnace loader; Reduction furnace operator	15	20	23	23	23
Furnace operator/unloader; Bottom furnace operator; Generic lead operator	68	31	118	107	41
KB-2/Reduction lead operator; Shift foreman; Porter	45	40	26	36	27
Lift truck driver (operator)	30	15	17	22	8
Office employees/Clerk; Production clerk	13	16	7.8	14	9.5
Production machinist	380	14	7.5	11	7
Recast furnaceYM-5 lead operator	49	20	47	30	71
Residue man	66	145	115	300	24
Saw operator/man	30	33	34	425	13
Slag building operator	110	110	110	224	18
Top/Upper/Generic “F” machine operator; Top(-ping) operator; Jolter	28	49	46	113	24
Top/upper furnace operator; Decontamination man	21	21	30	34	26

This table is derived from the data given in Table 14 and from supplementary information in the references.

An “X” indicates that the job title did not exist during the indicated period. An “X?” indicates that it is uncertain if the job title existed, i.e., it is not certain when that job began.

Table 22. Radioactive dust daily weighted average exposure levels, Plant 7 (including the Slag Separation Plant) and Plant 7E.

Job title	Airborne dust exposures, alpha dpm/m^3					
	1951	1952	1953	1954	1955	1956 – 1958
Plant 7						
Area mechanic; Welder	37	14	37	7	13	14
Asst foreman/Plant superintendent/Engineer	22	21	10	7	70	32
Clerk/Record clerk; Porter	22	21	10	13	32	32
Decontamination man/Decontaminator	161	21	12	9	17	18
Filter/Tables operator*	X	X	X	X	9	9
Foreman/Technical supervisor; Safety inspector/Fire marshal	28	28	22	12	16	18
Furnace operator/Utility operator	25	28	67	23	18	17
HF/Magnesium Room operator	8	14	9	5	5	5.3
Hoisting (slag) operator*	x	X	X	X	15	15
Lead (UO_3-to-UF_4, TA-7) Operator; 36' Level/Panel board operator**	38	21	17	9	30	30
Lift truck driver (operator)	14	14	10	14	26	41
QM-2 dumper/hoister	107	56	61	42	63	112
Safety clerk	17	17	17	9	14	14
Sampler and cleanup man	X	28	286	8	8	9.1
TA-7 hoisting operator (hoister)	121	14	13	13	11	17
TA-7 (green/UF_4) packager	242	28	103	68	49	24
Plant 7E (thorium/ionium) process)						
Ionium plant operator/lead operator***	X	X	X	X	0.1	0.3

This table is derived from the data given in Table 15 and from supplementary information in the references.

An "X" indicates that the job title did not exist during the indicated period. An "X?" indicates that it is uncertain if the job title existed, i.e., it is not certain when that job began.

UO_3 processing operations continued until July 1958 (Mallinckrodt 1994), but most other operations stopped in 1957. Plant 7E was said to be in its startup phase when the only known measurements were taken in March 1955 (AEC 1955e); these may have been taken as part of bench-scale processing (AEC 1955c). Thus as AEC (1955e) noted, the full processing figures would likely be higher. Thus figures for 1956 and 1957 have been tripled to allow for full processing. Processing ceased at some point in late 1956 or very early 1957, so an end date of March 1957 should be taken.

* These positions began after July 1955. Clearly, this was in the pilot plant (as implied by the information in AEC 1955c).

** The 36' Level operator position began in 1953, the panel board operator position in 1952.

**The ionium pilot plant work began after July 1955 and continued until March 1957 (AEC 1955c).

Table 23. Early radon data, 1945.

	% Tolerance	Ventilation condition	Reference
Bldg 40 storeroom, 1000 lbs ore and active residues	724	F	MED 1945f
Bldg 40, center of storeroom between stacks of residue drums	<15	F	MED 1945j
Bldg 40, residue storage: BZ, residue work -- floor covered with residue	<24		MED 1945g
Bldg K, center of storeroom with ore and residues	90	F	MED 1945j
Bldg K storeroom, center, 2-3 drums fresh residue and open drums of ore	25	F	MED 1945f
(Bldg K) Pilot Plant storeroom with 2000-3000 lbs of ore	50	F	MED 1945m
(Bldg K) Pilot Plant, over digestion tank during addition of ore	147	N	MED 1945m
(Bldg K) Pilot Plant, center of Pilot Plant during digestion	132	N	MED 1945m
(Bldg K) Pilot Plant, over digestion tank 15 minutes after digestion	18	N	MED 1945m
(Bldg K) Pilot Plant, N end, away from operation	216	N	MED 1945m
Bldg K, N end of room, away from operation	<15	N	MED 1945h
Bldg K, center of room	<22	N	MED 1945h
Bldg K, center of room, no operation	26	N	MED 1945j
(Bldg K) Pilot Plant, discharge end of Feinc filter during filtration	<15	N	MED 1945m
Bldg K, S end near Feinc filter, not operating	29	N	MED 1945j
Bldg K, S end of plant near Feinc filter, not operating	<15	N	MED 1945h
Bldg K, vicinity of Feinc filter, no operation	<12	W	MED 1945f
Bldg K, work desks at NE corner	12	W	MED 1945f
Bldg K, work desks, center of room	12	W	MED 1945f
Bldg K, alley outside at exhaust	<11		MED 1945f
Bldg K alley, directly under stack emitting brown fumes	<15	N	MED 1945j
Storeroom on RR siding, between 2 tiers of residue drums, 10' from each	32		MED 1945g
Plant 4, ore storage: center of room with 1800 lbs ore	211	F	MED 1945h
Plant 4(?), W end of ore room during full operation	65	F, N	MED 1945i
Plant 4, W end or ore milling area near sifter, full operation	58	F, N	MED 1945i
Plant 4, center of ore milling room near mill	113	F, N	MED 1945i
Plant 4, operator's hand when unloading ball mill, 300 lbs of ore, fan on	407	F	MED 1945f
Plant 4, near mill, 10 min after unloading, fan on	<15	FW	MED 1945f
Plant 4, opening at top of empty mill	<25		MED 1945f
Plant 4, ore milling area: no operation for 3 days	30	N	MED 1945h
Plant 4, residue storage: directly above drums of residue	763		MED 1945g
Plant 4, laboratory: center of cage	<26	N	MED 1945h
Plant 6 ore storage warehouse, SE corner	55	N	MED 1945k
Plant 6 ore storage warehouse, center of empty aisle	21	N	MED 1945k
Inside [unspecified] lab, no activity	<11		MED 1945f

* Fan on (F), windows open (W), natural ventilation (N)

The data above was taken at various times in 1945. The tolerance level was 1.0×10^{-10} Ci/L of radon.

"Bldg K" was apparently Building K1E, also known as a pilot plant.

Table 24. Measured radon concentrations, 1947-1949, in units of 1×10^{-10} Ci/L.

	1947				1948					1949			
	No.	Min	Med/ Mean	Max	No.	Min	Med/ Mean	Max	GSD	No.	Min	Med/ Mean	Max
INDOOR AREAS													
Ore Milling					11	0.03	0.39	0.81					
Ore Rm: open drums*											0.58	8.50	260
Ore Storage					27		0.46		3.28				
Ore Storage					58	0.03	0.30	2.86					
Thawing oven, K-65													
Heat off, fan off										28		3.84	
Heat off, fan on										36		0.60	
Heat on, fan on										18		4.06	
Outside, heat on										12		1.09	
Outside, heat off										24		0.07	
Thawing oven, K-65**										4	540	622	805
Scalehouse			0.10		21	0.00	4.05	33		44	0.03	0.45	4.4
Scalehouse	2		.60		193	0.03	2.02	32.8		158	0.03	1.03	
Scalehouse	5	.09	.27	.84									
Scalehouse/Ore Storage/Warehouse	4	.55	.69	.92								5.00	
Scalehouse Sample Rm	46	0.0	2.40	13	6	0.22	4.10	19					
Scalehouse Sample Rm	3	.06	.09	.12	68	0.03	2.84	25					
Digest/Feed	4	.05	.23	.52	57	0	0.39	7.8					
Extraction Cells					14	0	1.08	4.1					
Centrifuge Area	2		.38		74		1.00			74	0.00	0.76	3.86
Centrifuge Area					141	0	1.13	12		48	0	1.55	12
Feinc/Filter/C-3/Raffinate/Cloth Storage/Niagara	4	.08	.12	.2	9		0.18		1.98				
Feinc/Filter/C-3/Raffinate/Cloth Storage/Niagara					56	0.00	0.05	9.74					
Feinc/Filter/C-3/Raffinate/Cloth Storage					186	0	12.3	894		172	0	0.75	468
Ledoux Lab					30	0	0.08	0.4					
Recovery area (aisle betw Recovery and feed makeup)	4	.05	.16	.31									
Sump by M-19, skid of recovery cake beside sump			.26										
Maintenance Shop (aisle between shop and Feincs)	4	.04	0.11	.18									
Dispensary	3	.04	.07	.11									
YARDS AND OTHER OUTDOOR AREAS													
General Plant 6					35	0	0.19	2.1					
Bldg 104/Scalehouse	3	.07	0.17	.36	9		0.07		1.47				
Bldg 104 (Pilot Plant)					7	0	0.15	0.6					
Warehouse					17		0.10		2.05				
Warehouse exhaust					33	0.1	0.91	3.3					
Near warehouse, K-65 drum welding					8		0.11		2.84				
Labs, guard office					8		0.06		1.38				
Parking lot area					9		0.13		1.56				
Scalehouse intake/exhaust					3		0.12		2.06				
Scalehouse exhaust					18		0.13		3.08				
Scalehouse exhaust					1		0.93						
Scalehouse exhaust					24	0	2.2	49					
Ore storage intake/exhaust					6		0.68		2.44				
Ore storage exhaust					2		0.31		1.77				
Railcar, ore, fans on*					2	0.5	<1.00	7					
Drums outside Scalehouse					4	0.0	0.39	0.90					
K-65 drums in sun**										2	637	654	670
SLAPS													
In K-65 storage shed					5		4.2		3.2				
At K-65 storage shed												19	
15 ft from K-65 shed					2	0.04	0.99	24	93				
25-30 ft, K-65 shed					2		7.8		1.6			6.6	
50 ft from K-65 shed					3		3.8		2.1			4.4	
50-120 ft, K-65 shed					13		2.1		5.0				
100 ft from K-65 shed												2.4	
150 ft from K-65 shed, at guard shack					3	0.00	0.21	1.1	14			1.4	
180-250 ft, K-65 shed					5		1.1		5.8				
200 ft from K-65 shed												0.94	

Table 24 (Continued)

Values in this and the next table are taken from AEC (AEC 1948b; AEC 1949; AEC 1948j; AEC 1949j) and MCW (various, MCW 1950b; MCW 1948I; MCW 1948e; MCW 1948j; MCW 1948e; MCW 1951c; MCW 1949f).

Where there was only a single measurement for the time period, the value is given above in the Median/Mean column. Where there were only a minimum, average, and maximum reported, the three values are given above in the Min, Median/Mean, and Max columns. Where there were two or more measurements and the data were given in full, a lognormal distribution was used for the analysis and the geometric mean and geometric standard deviation (GSD) are given above in the Median/Mean and GSD columns. In each case where the number of measurements was given in the reference, the number is given above in the No. column.

Control readings were taken in the Dispensary. Measurements were taken at face level whenever possible.

* The single asterisked items are an exception to the note above. For the Ore Room case, the value in the Min column is the point at which the concentration drops below 1×10^{-10} Ci/L (25 minutes), the value in the Mean column is the average concentration over the elapsed time (i.e., the 25 minutes), and the value in the Max column is the value at time zero. For the railcar case, the value in the Min column is the average of readings at about 3.5 hours (stable concentration), the value in the Mean column is the point at which the concentration drops below 1×10^{-10} Ci/L (about 20 minutes), and the value in the Max column is the average value at time zero. More information can be found in MCW (MCW 1949m) and MCW (MCW 1948h) respectively.

** The double asterisked items correspond to samples taken of the standard 30-gallon K-65 drums sitting inside sealed 55-gallon drums (to facilitate sampling) after heating in the thawing oven or being allowed to heat in the sun (MCW 1949r); these thus represent the maximum radon evolved over 2-4 hours of heating, concentrated in the larger drum head space but not actually in the breathing zone.

Table 25. Measured radon concentrations, 1950-1957, in units of 1×10^{-10} Ci/L.

	1950			1951			1952			1953			1954					1955			1956			1957		
	No.	Med/ Mean	GSD	No.	Med/ Mean	GSD	No.	Med/ Mean	GSD	No.	Med/ Mean	GSD	No.	Min	Med/ Mean	Max	GSD	Min	Med/ Mean	Max	No.	Med/ Mean	GSD	No.	Med/ Mean	GSD
INDOOR AREAS																										
Scalehouse				35	0.09	5.9	95	0.09	6.0	66	0.01	5.0														
Scalehouse		1.02																								
Scalehouse/Ore Storage/Warehouse													74		0.01		5.4	5	0.01	1.00						
Scalehouse Sample Room																		0.09	0.24	0.50						
Digest/Feed				2	0.05	11				17	0.12	5.2	57		0.03		3.8				18	0.01	5.1	3	0.03	5.5
Extraction Cells				33	0.36	5.9	92	0.37	5.3	59	0.28	3.8	101		0.26		5.8				33	0.01	7.0	3	0.01	8.7
Centrifuge Area	8	0.11	2.3	35	0.06	4.8	95	0.12	5.0	55	0.05	5.6	51		0.07		6.5				7	0.01	5.2	3	0.01	1.0
Feinc/Filter/C-3/ Raffinate/Cloth Storage/Niagara		34		34	0.18	3.7	94	0.14	4.1	60	0.10	4.8	114		0.14		6.2	<.01	0.50	1.7	41	0.07	5.8	5	0.01	6.8
Orange Packing													1	0.12	0.12	0.12										
Pot Room													2		0.02		2.2									
Ledoux Lab										6	0.10	1.3	10		0.02		3.4									
Shotgun Lab													2		0.04		5.8									
Other Lab (Research/Con-trol/X-ray/MY)													3		0.01		1.0							2	0.04	8.0
6E Breakout													3		0.01		1.0									
6E Recast													4		0.01		1.0									
Recovery area													1	0.11	0.11	0.11										
Decontamination Room													1	0.01	0.01	0.01										
Metal Dissolver Bldg													4		0.01		2.6									
NA House													3		0.01		16									
Ether House													2		0.02		2.7									
Refrigeration Room													1	0.01	0.01	0.01										
Receiving													1	0.01	0.01	0.01										
Welding Shop													1	0.01	0.01	0.01										
Millwright Shop													1	0.01	0.01	0.01										
Electric shop													3		0.01		1.0									
Maintenance Shop													3		0.04		6.9									
Smoking Room													1	0.01	0.01	0.01										
Production Office													1	0.01	0.01	0.01										
Dispensary													2		0.04		6.1									
YARDS AND OTHER OUTDOOR AREAS																										
Ether House/ Bldg 109													1	0.01	0.01	0										
Drum storage outside Bldg 115													3		0.30		8.6									

Values in this and the next table are taken from AEC (AEC 1948b; AEC 1949; AEC 1948j; AEC 1949j) and MCW (MCW various, MCW 1950b; MCW 1948l; MCW 1948e; MCW 1948j; MCW 1948e; MCW 1951c; MCW 1949f).

Where there was only a single measurement for the time period, the value is given above in the Median/Mean column. Where there were only a minimum, average, and maximum reported, the three values are given above in the Min, Median/Mean, and Max columns. Where there were two or more measurements and the data were given in full, a lognormal distribution was used for the analysis and the geometric mean and geometric standard deviation (GSD) are given above in the Median/Mean and GSD columns. In each case where the number of measurements was given in the reference, the number is given above in the No. column.

Table 26. Potential radon exposures from thorium processing.

Isotope	Maximum radon content, Ci	Average concentration, Ci/L
Rn-220	8.46×10^{-4}	5.37×10^{-13}
Rn-222	0.158	1.00×10^{-10}

The maximum radon content is from Table 6, assuming a 15-year buildup.

Emanation is based on an assumption of 1% radon content outgassed to the room; this should be conservative, since most rad0j would have been vented when the cake containers were opened in a well-ventilated area, as for ore, or when the cake was in the digestion vessels. The total number of working hours is 2000 per year for 1.75 years (July 1955-March 1957), or 3500 hours. Thus the emanation per working hour is 1% of the maximum ore content, divided by 3500 hours.

The average concentration is based on a conservative assumption of 2 air changes per hour (i.e., minimal ventilation) in a room measuring 3 m × 3 m × 2.5 m (about 10 ft × 10 ft × 7.5 ft), a conservatively small process area. This gives an air volume of 22,500 liters in the room and an hourly air change volume of 45,000 liters. The emanation per working hour is divided by the air change volume to produce the average concentration.

Table 27. Contamination levels and associated dose rates from work clothing.

Surface contamination measurements for various types of work clothing					
	Spot		Whole garment or group		
Item	Max	Average	Max	Average	Contamination notes
Regulated coveralls	80% had ≥ 1-2 in^2 spot >3000 cpm	Most coveralls had more than 1 spot >1 mr/hr	60% had ≥ 1 mrep/hr over whole garment	1.5 mrep/hr; range, 0.2 to 12; 100% had avg >100 cpm per 2 in^2	Apparent U spots on 70%; area was from 10 cm^2 to 30% of total area
Nonregulated coveralls	30% have more than 1 spot >1000 cpm		100% <3 mrep/hr	80% <1 mrep/hr; 0% with avg <100 cpm	5% visibly contaminated
Handkerchiefs	>1,000 cpm			<300 cpm	10% visibly contaminated
Socks			800 cpm	200 cpm	
Underwear			800 cpm	200 cpm	
Caps				300 cpm	Low to moderate
Blue smocks	>1,000 cpm			200 cpm	Low to moderate
White smocks	>1,000 cpm				More than blue smocks (more spots)
Lab smocks	>1,000 cpm			<300 cpm	Low (few spots)
Gloves				~5,000 cpm per 2 in^2	All: heavy
Shoe covers				>90% have >1,000 cpm	"Destrehan": "high"
Gloves, contaminated on the inside			47 mrep/hr	Range 23-47 mrep/hr	Beta dose rate, on contact with the inside
Shielding of beta radiation by various materials					
Item	Distance	Reduction factor	Std deviation		
Coveralls, 9-oz denim	5 inches–3 ft	.78	7.5%		
Gloves, neoprene-covered cotton		.50			3 gloves were measured

Measurements of surface contamination on clothing are from Utnage (1958b); measurements of beta shielding and exposure rates inside gloves are from AEC (AEC 1950j). Measurements were taken after wearing but before washing; gloves contaminated on the inside were taken at random from workers actually using the gloves and were not discarded gloves.

The beta reduction factor is the ratio of shielded dose rate to unshielded dose rate. The source was a sheet of uranium metal, 18" x 24", in equilibrium with UX1 and UX2.

The "smocks" appear to be cover clothing.

Table 28. Surrogate (comparable) worker inhalation intakes calculated from urinalysis data, in pCi/yr.

Category	Type	Median or *Actual	GSD	No. Cases	Median or *Actual	GSD	No. Cases	Median or *Actual	GSD	No. Cases
Plant 6		Period 123			Period 1			Period 23		
	Generic (mixed, miscellaneous, or unknown)	2.51E+04	1.62	21	8.29E+04	1.87	13	2.12E+04	1.78	7
	Mostly Cloth, Raffinate, Feinc	--	--	--	5.61E+04	2.71	3	2.87E+04	1.16	3
	Mostly Digest	2.10E+04	1.70	3	4.45E+04	2.54	3	*1.98E+04	--	1
	Mostly Ether House	2.19E+04	1.64	5	3.08E+04	1.22	4	2.32E+04	1.00	3
	Mostly Packaging	--	--	--	1.28E+05	5.13	3	--	--	--
	Mostly Pot Room, Orange Oxide	--	--	--	1.80E+05	2.01	5	2.26E+04	2.32	5
		Period 12			Period 1			Period 2		
	Mostly re Room	*2.45E+05-4.96E+04	--	2	*4.83E+04 - 5.96E+04	--	2	*3.84E+04	--	1
Plant 6E		Period 123			Period 1			Period 23		
	Generic (mixed, miscellaneous, or unknown)	2.98E+04	1.57	12	4.79E+04	2.29	4	3.12E+04	1.55	13
	Bomb Step (UF4→Derby)	3.19E+04	1.40	3	2.30E+04	1.51	4	2.59E+04	1.94	6
	Recast (Derby→Ingot)	*2.49E+04 - 2.02E+04	--	2	4.71E+04	1.78	3	3.44E+04	1.66	4
		Period 12								
	Graphite Shop	1.56E+04	1.57	3						
Plant 4		Period 123			Period 1			Period 23		
	4 Metal (Derby, Ingot)	--	--	--	1.24E+05	2.54	11	--	--	--
	4 Pilot Plant (Dingot, Metallurgical, etc.)	*1.65E+04 - 1.04E+04	--	2	2.29E+04	2.40	3	2.92E+04	1.62	8
Plants 4 & 7		Period 123			Period 1					
(Green Salt)	UF4 Production Work, First at 4, Then at 7	1.81E+04	1.57	8	1.18E+05	4.48	7			
Plant 7		Period 23			Period 2					
	Generic (mixed, miscellaneous, or unknown)	1.67E+04	1.50	16	2.18E+04	1.87	7			
Multi-Plant		Period 123			Period 1			Period 23		
	AEC	*7.20E+03 - 6.94E+03	--	2	1.96E+04	1.59	5	*6.01E+03 - 1.60E+04	--	2
	Decon/Cleanup	1.44E+04	1.23	3	--	--		--	--	--
	Boiler House/Power House	1.11E+04	1.22	6	1.73E+04	1.55	6	*1.23E+04	--	1
	Engineering	1.08E+04	1.40	7	3.38E+04	1.55	10	9.71E+03	1.25	10
	Instrument Shop	1.26E+04	1.30	6	2.13E+04	1.91	7	--	--	--
	Laboratories (Anal., Research, Ledoux, etc.)	1.11E+04	1.50	24	2.30E+04	2.10	22	1.17E+04	1.42	23
	Laundry	1.10E+04	1.43	6	1.73E+04	2.82	8	*9.06E+03 - I72.20E+04	--	2
	Maintenance									
	Carpenter	*9.17E+03	--	1	--	--	--	--	--	--
	Electrical/Electrician	1.66E+04	1.55	7	5.19E+04	1.63	7	--	--	--
	Insulator/Pipe Coverer	*3.25E+04	--	1	--	--	--	--	--	--
	Machinist/Machine Shop	*4.17E+04	--	1	--	--	--	--	--	--
	Mechanic/Millwright	1.75E+04	1.72	10	7.05E+04	1.79	9	2.40E+04	1.66	4
	Miscellaneous/Mixed	1.46E+04	1.45	12	3.57E+04	2.22	12	--	--	--

Table 28 (Continued)

Category	Type	Median or *Actual	GSD	No. Cases	Median or *Actual	GSD	No. Cases	Median or *Actual	GSD	No. Cases
Multi-Plant, continued	Oiler	*1.76E+04	--	1	--	--	--	--	--	--
	Painter	1.49E+04	1.42	5	1.70E+04	1.56	6	--	--	--
	Pipefitter	2.42E+04	2.00	7	2.65E+04	2.33	9	--	--	--
	Rigger	*3.24E+04 - 1.48E+04	--	2	--	--	--	--	--	--
	Tinner	*2.49E+04	--	1	*3.23E+04	--	1	--	--	--
	Welder	2.62E+04	1.54	7	3.30E+04	1.35	6	*6.63E+03 - 9.43E+03	--	2
	Office Workers	9.74E+03	1.36	23	1.98E+04	1.66	15	1.10E+04	1.81	6
	Porter/Custodian	1.12E+04	1.30	7	2.94E+04	2.45	9	8.55E+03	1.24	3
	Safety & Health, Fire	8.23E+03	1.37	3	2.06E+04	1.95	6	1.35E+04	1.87	5
	Shipping & Receiving, Warehouse, Storeroom, Fork Truck Operator	1.11E+04	1.46	22	1.52E+04	2.32	20	9.63E+03	1.20	3
	Supervision & Management (where not specified by plant)	1.95E+04	1.48	7	3.46E+04	2.88	7	--	--	--

A lognormal distribution was used. The median and the geometric standard deviation (GSD) are shown. However, where only one or two suitable cases were found, no distribution could be formulated. Thus only the one or two actual results from IMBA are given; this is indicated by an asterisk (*). The non-distribution case figures indicate what may be known regarding the exposure of a comparable worker.

The sample size was assumed to be 1.4 l; the assumed activity equivalence is .676 pCi per ug nat U (or 676 pCi/mg); the sample data were in mg U/l; and IMBA uses 365 days of exposure per year. Hence the conversion factor for input data in mg U/l was 676 pCi per mg U x 1.4 l = 946 pCi-l/mg, to give pCi; the conversion factor for IMBA output data in pCi/day was 365, to give pCi/year; and the overall conversion factor was thus 3.45×10^4.

Period 1 is from 1948-1951; Period 2 from 1952-1955; and Period 3 from 1956-1958. Period 123 includes all three periods, Period 23 includes only the last two periods, and so forth. Major improvements were made in 1949-1951. Thus after this period, exposures went down in many areas and for some occupations. Increases in exposures in other areas and for other occupations are likely due to increases in production.

In IMBA, the assumption was made that all of the uranium measured was U-234 and Type M was used. The daughters assumed to be in equilibrium in the U-238 and U-235 chains must be added by the dose reconstructor when appropriate (see Section 6.1 of the text).

Table 29A. Annual inhalation intakes, Plants 1 and 2, April 1942-1945.

Job title	Intake, pCi/yr
Barium operator	1.96E+03
Boiler/Ether House/Nitric acid operator	5.02E+04
Centrifuge/wash filter operator	6.19E+05
Chemist (generic)	2.67E+05
Cloth operator	7.26E+05
Crafts: Carpenter/Pipefitter/Welder	1.37E+05
Digest/Extraction/Reduction operator	7.48E+05
Dispensary: Nurse/Medic/Other (personnel)	1.91E+05
Engineer (research or chemical)	5.02E+04
Feinc/Feed operator	1.07E+06
Foreman//Technical supervisor	1.76E+05
Furnace operator	2.70E+07
Guard/Chief guard	3.49E+04
Health/Safety field personnel	5.02E+04
Health/Security office personnel	1.64E+04
Instrument Shop machinist/technician	2.75E+05
Laboratory (generic)	4.89E+05
Laboratory office personnel	1.09E+05
Laboratory personnel (chemist, technician)	2.67E+05
Maintenance supervisor	5.46E+04
Manufacturing (generic)	7.26E+05
Mechanic/Area mechanic	2.06E+05
Miller (UO_3/QM-2)	1.37E+07
Office (generic)	5.46E+04
Office, administrative: Clerk/Office maintenance/Messenger/Porter/AEC	5.46E+04
Office, Production and Receiving: Bookkeeper*	3.13E+05
Office, Production and Receiving: Clerk/Secretary	1.76E+05
Ore Area/Room operator	1.50E+07
Pot Room operator	8.48E+06
Production superintendent/Asst production superintendant	2.73E+04
QM-2 (orange) loader	5.80E+06
QM-2 (orange) packager	1.53E+06
Raffinate/Sump operator	2.98E+05
Stockroom foreman/clerk	2.29E+04
Truck/forktruck operator/driver	8.18E+04
UO2/LF-9/Brown packager/unloader	4.25E+07
Warehouse foreman/assistant foreman/warehouseman/railcar handling	2.14E+05
Workman (generic)	7.26E+05

The bolded entries represent generic choices if the specific job title cannot be determined. The generic entries represent medians for the job titles associated with the generic process.

* The “bookkeeper” title in early film badge records appears to indicate a production area accountability clerk, not an office worker. Thus 25% production area access is assumed.

Table 29B. Annual inhalation intakes, Plant 4, October 1942-1958.

Job title	Intake, pCi/year								
	Oct 1942 - 1946	1947	1948 - 1949	1950	1951	1952 – 1953	1954 - 1955	1956	1957-1958
Blender/Bomb makeup	3.28E+06	3.28E+06	3.28E+06	2.29E+05	6.98E+04	6.98E+04	3.60E+04	9.27E+04	---
Bomb charger/ Charger	3.28E+06	3.28E+06	3.28E+06	2.29E+05	6.98E+04	6.98E+04	3.60E+04	9.27E+04	---
Cage operator/man	3.98E+06	3.98E+06	3.98E+06	2.07E+05	---	---	---	---	---
Carpenter/Other craft	1.53E+05	1.53E+05	1.53E+05	9.16E+04	1.64E+04	1.64E+04	2.40E+04	2.40E+04	---
Casting operator	5.56E+06	9.93E+05	1.07E+06	1.53E+05	5.24E+05	5.24E+05	1.20E+05	1.20E+04	---
Charge firing (man)	1.02E+06	9.93E+05	1.07E+06	1.53E+05	---	---	---	---	---
Chemist/technician: miscellaneous	4.36E+04	4.36E+04	4.36E+04	4.36E+04	7.64E+03	7.64E+03	1.09E+04	1.09E+04	---
Chemist/technician: vacuum fusion	---	---	---	---	---	6.44E+04	6.44E+04	6.44E+04	---
Chipper	2.06E+06	2.06E+06	9.93E+05	1.53E+05	1.53E+05	1.53E+05	1.53E+05	1.53E+05	1.53E+05
Cleanup man	2.06E+06	2.06E+06	9.93E+05	1.53E+05	1.53E+05	1.53E+05	1.53E+05	1.53E+05	1.53E+05
Dingot lead operator	1.02E+06	6.87E+05	6.11E+05	3.82E+04	2.07E+04	2.07E+04	8.95E+03	2.07E+04	---
Dingot operator	3.28E+06	3.28E+06	3.28E+06	2.29E+05	6.98E+04	6.98E+04	3.60E+04	9.27E+04	---
Derby unloader	3.82E+05	3.05E+05	1.37E+06	1.91E+05	---	---	---	---	---
Engineer/Technical supervisor	1.91E+05	1.91E+05	1.91E+05	6.11E+04	1.31E+04	1.31E+04	1.09E+04	2.51E+04	---
Foreman/Shift foreman	1.91E+05	1.91E+05	1.91E+05	6.11E+04	1.31E+04	1.31E+04	1.09E+04	2.51E+04	---
Forge press operator/manipulator	---	---	---	---	---	2.51E+04	2.51E+04	2.51E+04	---
Furnace and saw man	---	---	---	---	1.96E+04	1.96E+04	1.96E+04	1.96E+04	---
Furnace loader (UF_4-derby)	3.67E+06	3.67E+06	2.44E+06	3.05E+05	---	---	---	---	---
Furnace (recast) operator	5.56E+06	9.93E+05	1.07E+06	1.53E+05	5.24E+05	5.24E+05	1.20E+05	1.20E+04	---
Furnace puller	1.02E+06	6.87E+05	6.11E+05	3.82E+04	2.07E+04	2.07E+04	8.95E+03	2.07E+04	---
Furnace tender	6.11E+05	6.11E+05	3.82E+05	7.64E+04	---	---	---	---	---
Guard/Chief guard	3.05E+04	3.05E+04	3.05E+04	3.05E+04	3.05E+04	6.33E+03	2.95E+03	7.75E+03	---
HF (fluorination) operator	6.22E+05	6.22E+05	6.22E+05	7.64E+04	---	---	---	---	---
Jolter	3.82E+06	3.82E+06	5.35E+05	7.64E+04	---	---	---	---	---
KB-2 lead operator	1.02E+06	6.87E+05	6.11E+05	3.82E+04	2.07E+04	2.07E+04	8.95E+03	2.07E+04	---
KB-2/Derby production (generic for reduction operations)	1.02E+06	9.93E+05	1.07E+06	1.53E+05	6.98E+04	6.98E+04	3.60E+04	9.27E+04	1.53E+05
Laboratory: ceramics/microscopy	---	---	---	---	1.96E+04	1.96E+04	1.96E+04	1.96E+04	---
Lime blender/Magnesium operator	7.64E+04	7.64E+04	7.64E+04	3.82E+04	---	---	---	---	---
Manufacturing (generic)	1.02E+06	9.93E+05	1.07E+06	1.53E+05	2.07E+04	2.29E+04	2.51E+04	2.40E+04	1.53E+05
Mechanic/Area mechanic	3.82E+05	3.82E+05	3.82E+05	9.16E+04	1.64E+04	1.64E+04	2.40E+04	2.40E+04	---
Miller-mixer (UF_4/TA-7)	5.12E+06	5.12E+06	1.07E+06	7.64E+04	---	---	---	---	---
Office: Plant superintendent/ Clerk/Other	4.58E+04	4.58E+04	4.58E+04	4.58E+04	4.58E+04	6.33E+03	2.95E+03	7.96E+03	---
Ore miller/handler	7.86E+05	---	---	---	---	---	---	---	---
Porter	1.22E+05	1.22E+05	1.22E+05	6.11E+04	6.11E+04	6.33E+03	2.95E+03	4.36E+04	---
Residue man	---	---	---	---	---	---	3.05E+04	3.05E+04	---
Salt bath man/Vertical lathe operator	---	---	---	---	---	---	3.05E+04	3.05E+04	---
Saw operator/man	2.06E+06	2.06E+06	9.93E+05	1.53E+05	1.53E+05	1.53E+05	1.53E+05	1.53E+05	1.53E+05
Shipping & Receiving	1.37E+05	1.37E+05	1.37E+05	1.37E+05	1.64E+04	1.64E+04	2.40E+04	2.40E+04	---
Slag man/Slag grinding operator	1.53E+05	1.53E+05	2.29E+05	7.64E+04	---	---	---	---	---
TA-7 packager	7.87E+06	7.87E+06	7.87E+06	2.67E+05	---	---	---	---	---
TA-7 unloader (operator)	1.42E+07	1.42E+07	1.68E+06	2.29E+05	---	---	---	---	---
Top cleaner	5.12E+06	5.12E+06	1.07E+06	7.64E+04	---	---	---	---	---
Topper	9.16E+05	9.16E+05	2.52E+06	2.29E+05	---	---	---	---	---
Top seat man	5.56E+06	9.93E+05	1.07E+06	1.53E+05	5.24E+05	5.24E+05	1.20E+05	1.20E+04	---
UF4/TA-7/green production (generic)	2.80E+06	2.18E+06	8.46E+05	8.40E+04	1.85E+04	1.85E+04	1.65E+04	2.24E+04	---
UO2/LF-9 loader/packer	4.58E+06	3.67E+06	2.44E+06	3.05E+05	---	---	---	---	---
YM-5 lead operator	1.02E+06	6.87E+05	6.11E+05	3.82E+04	2.07E+04	2.07E+04	8.95E+03	2.07E+04	---
YM-5/billet/dingot production (generic for recast operations)	3.63E+06	9.95E+05	1.07E+06	1.53E+05	6.98E+04	4.75E+04	3.05E+04	2.07E+04	---

Although plant operations likely ended in 1957, the end year of operations is taken conservatively to be 1958 (see Section 8.0).

The bolded entries represent generic choices if the specific job title cannot be determined. The generic entries represent medians for the job titles associated with the generic process.

Table 29C. Annual inhalation intakes, Plant 6, 1946-1958.

Job title	Intake, pCi/year							
	1946 - 1948	**1949**	**1950**	**1951**	**1952**	**1953**	**1954**	**1955 – 1958**
AEC engineer	---	---	---	7.64E+03	3.38E+04	1.08E+04	2.07E+04	2.07E+04
Barium operator	1.96E+03	1.96E+03	1.37E+05	1.57E+05	1.42E+05	4.15E+04	---	---
C-3 centrifuge/wash filter/ adjustments operator	6.19E+05	6.19E+05	1.53E+05	1.53E+05	4.58E+05	6.87E+05	8.62E+04	8.62E+04
Cleanup man/utility operator	---	---	---	1.06E+05	1.06E+05	1.03E+05	1.41E+05	9.60E+04
Cloth operator	7.26E+05	7.26E+05	2.67E+05	2.67E+05	1.00E+05	2.07E+04	1.96E+04	1.96E+04
Cloth & Training Group lead operator/trainer	2.75E+06	2.75E+06	2.52E+05	2.52E+05	2.51E+04	2.73E+04	1.96E+04	1.96E+04
Clothes issue man	1.00E+05	1.00E+05	1.00E+05	1.00E+05	1.00E+05	1.03E+04	2.07E+04	1.96E+04
Crafts: Carpenter/Pipefitter/Welder	1.37E+05	1.37E+05	1.07E+05	3.05E+04	3.05E+04	3.05E+04	3.16E+04	2.62E+04
Decontamination man/U-con man*	1.08E+05	1.08E+05	1.08E+05	1.08E+05	6.55E+04	2.07E+04	2.40E+04	1.85E+04
Cloth/Digest/Reduction operator, Outside sampling	7.48E+05	7.48E+05	2.67E+05	4.04E+05	1.00E+05	4.47E+04	6.55E+04	2.40E+04
Dispensary: Nurse/Medic/Other (personnel)	1.91E+05	1.91E+05	6.11E+04	1.08E+05	4.58E+04	6.87E+03	3.82E+03	1.42E+03
Boiler/Ether Hse/Extraction/Nitric acid rec'y operator	5.02E+04	5.02E+04	1.08E+05	5.46E+04	4.80E+04	2.07E+04	1.20E+04	3.71E+04
"Experimental Continuous Furnace": Pilot Plant project	---	9.32E+06	9.32E+06	---	---	---	---	---
Feinc/Feed/Soluble feed operator	1.07E+06	1.07E+06	1.68E+05	1.91E+05	1.64E+05	1.09E+05	1.05E+05	4.47E+04
Foreman/General foreman/Shift foreman/Technical supervisor	1.76E+05	1.76E+05	1.76E+05	1.05E+05	8.84E+04	3.27E+04	2.73E+04	2.07E+04
Furnace operator	2.70E+07	2.70E+07	1.53E+06	1.64E+05	1.05E+05	6.00E+04	3.60E+04	1.31E+04
Guard/Chief guard	3.49E+04	3.49E+04	3.49E+04	1.96E+03	2.40E+04	1.75E+04	1.53E+04	1.09E+04
Health/Security Office personnel; Engineer (MCW, chemical)	1.64E+04	1.64E+04	1.64E+04	7.64E+03	1.53E+04	1.64E+04	1.20E+04	8.84E+03
Health Office: health surveyor/plant monitor	5.02E+04	5.02E+04	5.02E+04	4.58E+04	1.53E+04	1.64E+04	1.75E+04	1.64E+04
Instrument Shop machinist/technician	2.75E+05	2.75E+05	5.56E+04	6.55E+04	4.36E+04	1.85E+04	4.80E+04	1.31E+04
Laboratory Office personnel	1.09E+05	1.09E+05	1.09E+04	6.11E+03	6.11E+03	6.11E+03	2.18E+03	4.58E+04
Laboratory: chemist/technician (generic/MCW/Shotgun)	4.89E+05	2.67E+05	2.62E+04	2.73E+04	2.51E+04	3.27E+04	1.09E+04	4.58E+04
Laundry operator/lead operator	---	---	---	4.91E+03	2.07E+04	1.20E+04	2.07E+04	6.76E+03
Ledoux Lab technician/asst technician - raffinate, MgF_2	2.06E+05	2.06E+05	9.93E+04	4.58E+05	1.53E+05	4.25E+04	8.84E+03	2.95E+04
Ledoux Lab technician (K-65)	2.29E+06	2.29E+06	1.53E+06	2.07E+06	4.80E+05	2.95E+04	8.18E+03	2.29E+04
LF-9/brown/UO_2 packager/unloader	4.25E+07	4.25E+07	3.97E+05	3.82E+05	3.82E+05	---	---	---
Maintenance supervisor	5.46E+04	5.46E+04	5.46E+04	4.15E+04	4.58E+04	1.09E+04	1.42E+04	1.53E+05
Maintenance (generic)	2.06E+05	2.06E+05	2.95E+03	3.05E+04	3.05E+04	3.05E+04	3.16E+04	2.62E+04
Manufacturing/Mfg (generic)	1.07E+06	7.48E+05	2.60E+05	1.77E+05	1.42E+05	4.47E+04	3.60E+04	2.62E+04
Mechanic/Area mechanic: C-3, digest, feed, furnace, Ore Room, raffinate, Ether/Nitric Acid House	2.06E+05	2.06E+05	2.95E+03	3.05E+04	3.05E+04	3.05E+04	3.16E+04	2.62E+04
Metal dissolver (#1, #2)	---	---	---	2.23E+05	2.23E+05	2.23E+05	2.23E+05	2.23E+05
Metal room sampler	---	---	---	4.58E+05	4.58E+05	4.58E+05	4.58E+05	4.58E+05
MgX operator	1.03E+05	1.03E+05	1.03E+05	1.03E+05	5.67E+04	7.42E+04	3.16E+04	3.16E+04
Miller (UO_3/QM-2)	1.37E+07	1.37E+07	---	---	---	---	---	---
Office (generic)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Office, MCW: Clerk/Office maintenance/Messenger/ Porter /Expeditor	5.46E+04	5.46E+04	5.46E+04	5.24E+04	5.24E+04	2.18E+04	1.85E+04	1.64E+04
Office: MCW - Other, AEC - all AEC except Engineer	5.46E+04	5.46E+04	5.46E+04	0.00E+00	7.31E+03	3.16E+03	2.40E+03	2.40E+03
Office, Production/Receiving: Clerk/Secretary	1.76E+05	1.76E+05	5.67E+04	1.08E+05	1.85E+04	1.96E+04	2.07E+04	9.93E+03
Ore Room operator***	1.50E+07	3.82E+05	4.28E+05	4.04E+05	1.85E+05	1.53E+05	1.53E+05	---
Pilot Plant engineer	1.34E+05	1.34E+05	5.78E+04	6.33E+04	4.25E+04	3.38E+03	7.53E+03	8.18E+03
Pilot Plant lead operator/group leader	2.67E+05	2.67E+05	1.15E+05	1.27E+05	8.40E+04	6.66E+03	9.60E+03	8.40E+03
Pilot Plant technician	2.67E+05	2.67E+05	1.15E+05	1.27E+05	8.40E+04	6.55E+03	1.00E+04	2.12E+06
Pot Room operator	8.48E+06	8.40E+05	3.67E+05	1.09E+05	2.07E+05	4.91E+04	1.23E+05	2.55E+05
Powder sample technician	3.44E+06	3.44E+06	2.37E+05	2.37E+05	6.22E+04	6.22E+04	6.22E+04	6.22E+04

Table 29C (Continued)

Job title	Intake, pCi/year							
	1946 - 1948	**1949**	**1950**	**1951**	**1952**	**1953**	**1954**	**1955 – 1958**
Power House (generic)	5.02E+04	5.02E+04	1.08E+05	5.46E+04	4.80E+04	2.07E+04	1.20E+04	3.71E+04
Production Research Lab personnel	9.16E+04	9.16E+04	1.31E+04	3.27E+04	1.42E+04	5.46E+03	2.18E+03	4.04E+03
Production superintendent/Asst production superintendant	2.73E+04	2.73E+04	2.73E+04	2.73E+04	2.84E+04	6.11E+04	2.29E+04	1.96E+04
QM-2 (orange) loader	5.80E+06	5.80E+06	1.53E+06	4.58E+05	4.58E+05	4.58E+05	---	---
QM-2 (orange) packager	1.53E+06	1.53E+06	1.53E+06	4.58E+05	1.42E+05	1.42E+05	1.31E+05	---
Raffinate/Sump recovery operator	2.98E+05	2.98E+05	1.68E+05	8.29E+04	1.85E+05	9.27E+03	1.20E+04	2.36E+05
Sample Room supervisor	4.89E+05	4.89E+05	2.67E+05	2.67E+05	2.67E+05	4.47E+04	4.47E+04	4.47E+04
Stockroom foreman/clerk	2.29E+04	2.29E+04	2.29E+04	3.60E+04	1.64E+04	3.71E+04	1.53E+04	4.04E+03
Storeroom (generic)	2.29E+04	2.29E+04	2.29E+04	3.60E+04	1.64E+04	3.71E+04	1.53E+04	4.04E+03
Truck/forktruck operator/driver	8.18E+04	8.18E+04	8.18E+04	8.18E+04	6.87E+04	2.18E+04	2.07E+04	2.18E+04
Warehouse (generic)	2.14E+05	2.14E+05	9.16E+04	7.64E+04	4.15E+04	2.18E+04	1.09E+04	6.33E+03
Warehouse foreman/assistant foreman/warehouseman	2.14E+05	2.14E+05	9.16E+04	7.64E+04	4.15E+04	2.18E+04	1.09E+04	6.33E+03
Warehouse K-65 sampler/weighmaster	2.14E+05	2.14E+05	9.16E+04	2.51E+05	2.95E+05	3.82E+05	3.82E+05	---

Although plant operations may have ended in 1957, the end year of operations is taken conservatively to be 1958 (see Section 8.0).

The bolded entries represent generic choices if the specific job title cannot be determined. The generic entries represent medians for the job titles associated with the generic process.

Table 29D. Annual inhalation intakes, Plant 6E, 1950-1958.

Job title	Intake, pCi/year				
	Oct 1950 - Dec 1952	1953	1954	1955	1956 -1958
Area mechanic	2.51E+04	2.51E+04	2.51E+04	3.93E+04	7.96E+04
Billet grinder	3.71E+04	3.71E+04	3.71E+04	4.64E+05	7.29E+05
Blender; Lime/slag blender	9.71E+03	1.52E+04	1.42E+04	1.20E+04	6.22E+03
Bottom furnace operator	7.42E+04	3.38E+04	1.29E+05	1.17E+05	4.47E+04
Bottom/Lower “F” machine operator	2.51E+04	1.64E+04	2.62E+04	5.67E+04	3.16E+04
Breakout operator/man	2.73E+04	3.55E+04	3.05E+04	4.58E+04	2.51E+04
Brushing man	---	---	---	5.13E+04	5.13E+04
Burnout man	1.75E+05	2.84E+04	2.51E+04	3.38E+04	4.25E+04
Cage grinding/cage operator/man	6.00E+04	1.21E+05	2.18E+04	3.82E+04	3.81E+05
Cage/4th saw man	1.85E+04	8.73E+04	2.29E+04	4.15E+04	4.15E+04
Capping man	8.84E+04	5.51E+04	3.38E+04	3.49E+04	4.58E+04
Chipper/Derby chipper	2.30E+06	2.30E+06	2.30E+06	2.30E+06	2.07E+04
Crafts: Maintenance/electrician/mechanic/millwright; Graphite Shop	4.91E+04	4.31E+04	2.51E+04	3.93E+04	7.96E+04
Crucible assembler	8.84E+04	5.51E+04	3.38E+04	3.49E+04	4.58E+04
Crucible loader	3.05E+04	9.44E+04	5.35E+04	2.07E+04	6.55E+04
Decontamination operator/man	2.29E+04	2.29E+04	3.27E+04	3.71E+04	2.84E+04
Engineer/Chemical engineer/Technical engineer	2.95E+04	1.47E+04	1.64E+04	2.62E+04	6.22E+03
Extra man	4.04E+04	4.80E+04	3.60E+04	4.15E+04	5.46E+04
F (machine) charger	4.04E+04	4.80E+04	3.60E+04	4.15E+04	5.46E+04
Foreman, Assistant/General	2.18E+04	1.36E+04	2.07E+04	2.95E+04	6.66E+03
Foreman, Shift	4.91E+04	4.36E+04	2.84E+04	3.93E+04	2.95E+04
Furnace (recast) operator/unloader	7.42E+04	3.38E+04	1.29E+05	1.17E+05	4.47E+04
Furnace (recast) unloader	7.42E+04	3.38E+04	1.29E+05	1.17E+05	4.47E+04
Furnace (reduction) loader	1.64E+04	2.13E+04	2.51E+04	2.51E+04	2.51E+04
Jolter	3.05E+04	5.29E+04	5.02E+04	1.23E+05	2.62E+04
KB-2/derby production (generic for reduction operations)	3.05E+04	4.36E+04	3.05E+04	4.36E+04	2.62E+04
Lead operator (generic)	7.42E+04	3.38E+04	1.29E+05	1.17E+05	4.47E+04
Lift truck driver (operator)	3.27E+04	1.58E+04	1.85E+04	2.40E+04	8.73E+03
Office employees/Clerk; Production clerk	1.42E+04	1.69E+04	8.51E+03	1.53E+04	1.04E+04
Porter	4.91E+04	4.36E+04	2.84E+04	3.93E+04	2.95E+04
Production machinist	4.15E+05	1.47E+04	8.18E+03	1.20E+04	7.64E+03
Recast furnace/YM-5 lead operator	5.35E+04	2.18E+04	5.13E+04	3.27E+04	7.75E+04
Reduction furnace operator	1.64E+04	2.13E+04	2.51E+04	2.51E+04	2.51E+04
Reduction/KB-2 lead operator	4.91E+04	4.36E+04	2.84E+04	3.93E+04	2.95E+04
Residue man (dust collector work)	7.20E+04	1.58E+05	1.25E+05	3.27E+05	2.62E+04
Saw operator/man	3.27E+04	3.60E+04	3.71E+04	4.64E+05	1.42E+04
Slag building operator	1.20E+05	1.20E+05	1.20E+05	2.44E+05	1.96E+04
Superintendent/Supervisor	2.95E+04	1.47E+04	1.64E+04	2.62E+04	6.22E+03
Top/upper furnace operator	2.29E+04	2.29E+04	3.27E+04	3.71E+04	2.84E+04
Top/Upper/Generic “F” machine operator; Top(-ping) operator	3.05E+04	5.29E+04	5.02E+04	1.23E+05	2.62E+04
Utility operator (sump recovery; extra hand)	4.04E+04	4.80E+04	3.60E+04	4.15E+04	5.46E+04
YM-5/billet production (generic for recast operations)	5.35E+04	3.38E+04	3.71E+04	3.93E+04	4.47E+04

Although plant operations may have ended in 1957, the end year of operations is taken conservatively to be 1958 (see Section 8.0). The bolded entries represent generic choices if the specific job title cannot be determined. The generic entries represent medians for the job titles associated with the generic process.

Table 29E. Annual inhalation intakes, Plant 7, 1951-1958.

Job title	Intake, pCi/year					
	1951	1952	1953	1954	1955	1956 – 1958
Area mechanic	4.04E+04	1.53E+04	4.04E+04	7.64E+03	1.42E+04	1.53E+04
Clerk/Record clerk; Porter	2.40E+04	2.29E+04	1.09E+04	1.42E+04	3.49E+04	3.49E+04
Decontamination man/Decontaminator	1.76E+05	2.29E+04	1.31E+04	9.82E+03	1.85E+04	1.96E+04
Engineer	2.40E+04	2.29E+04	1.09E+04	7.64E+03	7.64E+04	3.49E+04
Filter/Tables operator*	---	---	---	---	9.82E+03	9.82E+03
Foreman, Asst	2.40E+04	2.29E+04	1.09E+04	7.64E+03	7.64E+04	3.49E+04
Foreman	3.05E+04	3.05E+04	2.40E+04	1.31E+04	1.75E+04	1.96E+04
Furnace operator	2.73E+04	3.05E+04	7.31E+04	2.51E+04	1.96E+04	1.85E+04
HF Room/Magnesium Room operator	8.73E+03	1.53E+04	9.82E+03	5.46E+03	5.46E+03	5.78E+03
Hoisting (slag) operator*	---	---	---	---	1.64E+04	1.64E+04
Lead (UF_4/TA-7) operator	4.15E+04	2.29E+04	1.85E+04	9.82E+03	3.27E+04	3.27E+04
Lift truck driver (operator)	1.53E+04	1.53E+04	1.09E+04	1.53E+04	2.84E+04	4.47E+04
Panel board/36' level operator	4.15E+04	2.29E+04	1.85E+04	9.82E+03	3.27E+04	3.27E+04
Plant superintendent	2.40E+04	2.29E+04	1.09E+04	7.64E+03	7.64E+04	3.49E+04
UO_3/QM-2 dumper/hoister	1.17E+05	6.11E+04	6.66E+04	4.58E+04	6.87E+04	1.22E+05
Safety clerk	1.85E+04	1.85E+04	1.85E+04	9.82E+03	1.53E+04	1.53E+04
Safety inspector/Fire marshal	3.05E+04	3.05E+04	2.40E+04	1.31E+04	1.75E+04	1.96E+04
Sampler and cleanup man	---	3.05E+04	3.12E+05	8.73E+03	8.73E+03	9.93E+03
Supervisor, Technical	3.05E+04	3.05E+04	2.40E+04	1.31E+04	1.75E+04	1.96E+04
TA-7 hoisting operator (hoister)	1.32E+05	1.53E+04	1.42E+04	1.42E+04	1.20E+04	1.85E+04
TA-7 (green/UF4) packager	2.64E+05	3.05E+04	1.12E+05	7.42E+04	5.35E+04	2.62E+04
UF_4/TA-7/Green production (generic for UF_4 production operations)	4.15E+04	2.29E+04	4.04E+04	1.42E+04	1.96E+04	1.85E+04
Utility operator	2.73E+04	3.05E+04	7.31E+04	2.51E+04	1.96E+04	1.85E+04
Welder	4.04E+04	1.53E+04	4.04E+04	7.64E+03	1.42E+04	1.53E+04

The bolded entry represents a generic choice if the specific job title cannot be determined. The generic entry represents a median for the job titles associated with the generic process.

Table 29F. Annual inhalation intakes, Plant 7E, 1955-1957.

Job title	Intake, pCi/year	
	1955	1956 - 1957
Ionium plant operator/lead operator*	1.09E+02	3.27E+02

* The thorium/ionium (concentration) plant work began after July 1955 and continued until March 1957; thus the annual intakes here should be ratioed by the appropriate number of months worked (i.e., a maximum of 6 in 1955, 12 in 1956, and 3 in 1957). The ionium case should use the isotopic breakdown given in Section 6.1, Item 5.

Table 30. Annual radon intakes, St. Louis main site, 1942-1958, and SLAPS, 1945-1962.

Worker type	Years	General areas			Ore/K-65 open areas			Enclosed work areas			Annual Intake, WLM
		Occ Factor	Equil Factor	Radon, pCi/l	Occ Factor	Equil Factor	Radon, pCi/l	Occ Factor	Equil Factor	Radon, pCi/l	
All plants											
Plants 1, 2, 4, 6, 6E, 7: all workers and years except for those listed below	All	1.00	0.40	1.0	---	---	---	---	---	---	4.8E-02
Plants 1 and 2											
Process workers	1944-1945	0.50	0.40	2.0	0.25	0.50	132	0.25	1.00	29	2.9E+00
Ore and residue storage workers	1944-1945	0.50	0.40	2.0	0.25	0.50	55	0.25	1.00	32	1.8E+00
Laboratory workers	1944-1945	0.50	0.40	2.0	0.50	0.50	26	---	---	---	8.3E-01
Plant 4											
Ore milling and grinding workers	1944-1946	0.50	0.40	2.0	0.50	0.50	112	---	---	---	3.4E+00
Ore storage workers	1944-1946	0.50	0.40	2.0	0.25	0.50	487	---	---	---	7.4E+00
Laboratory workers	1944-1946	0.50	0.40	2.0	0.50	0.50	26	---	---	---	8.3E-01
Plant 6*											
Digest operator	1946-1950	0.50	0.40	2.0	0.50	0.50	394	---	---	---	1.2E+01
Digest operator	1951-1954	0.50	0.40	2.0	0.50	0.50	11	---	---	---	3.8E-01
Digest operator	1955-1957	0.50	0.40	2.0	0.50	0.50	2.5	---	---	---	1.2E-01
Extraction/Wash filter operator	1946-1950	0.50	0.40	2.0	0.50	0.50	1.1	---	---	---	8.0E-02
Extraction/Wash filter operator	1951-1954	0.50	0.40	2.0	0.50	0.50	31	---	---	---	9.8E-01
Extraction/Wash filter operator	1955-1957	0.50	0.40	2.0	0.50	0.50	1.0	---	---	---	7.8E-02
Guard office	1946-1954	1.00	0.40	6.0	---	---	---	---	---	---	2.9E-01
Guard office	1955-1957	1.00	0.40	2.0	---	---	---	---	---	---	9.6E-02
Health and Safety, Engineering, Dispensary	1946-1954	0.25	0.40	2.0	0.75	0.50	6.3	---	---	---	3.1E-01
Health and Safety, Engineering, Dispensary	1955-1957	0.25	0.40	2.0	0.75	0.50	2.0	---	---	---	1.1E-01
K-65/C-3 centrifuge operator	1946-1950	0.50	0.40	2.0	0.50	0.50	108	---	---	---	3.3E+00
K-65/C-3 centrifuge operator	1951-1954	0.50	0.40	2.0	0.50	0.50	8.5	---	---	---	3.0E-01
K-65/C-3 centrifuge operator	1955-1957	0.50	0.40	2.0	0.50	0.50	1.0	---	---	---	7.8E-02
Feinc/K-65/raffinate/cloth operator	1946-1950	0.50	0.40	2.0	0.50	0.50	580	---	---	---	1.7E+01
Feinc/K-65/raffinate/cloth operator	1951-1954	0.50	0.40	2.0	0.50	0.50	14.0	---	---	---	4.7E-01
Feinc/K-65/raffinate/cloth operator	1955	0.50	0.40	2.0	0.50	0.50	50	---	---	---	1.5E+00
Feinc/K-65/raffinate/cloth operator	1956-1957	0.50	0.40	2.0	0.50	0.50	6.3	---	---	---	2.4E-01
Laboratory, Ledoux	1946-1954	0.25	0.40	2.0	0.75	0.50	8.3	---	---	---	4.0E-01
Laboratory, Ledoux	1955-1957	0.25	0.40	2.0	0.75	0.50	8.3	---	---	---	4.0E-01
Laboratory, general	1946-1957	1.00	0.40	2.0	---	---	---	---	---	---	9.6E-02
Laboratory, Shotgun	1946-1954	0.25	0.40	2.0	0.75	0.50	4.0	---	---	---	2.0E-01
Laboratory, Shotgun	1955-1957	0.25	0.40	2.0	0.75	0.50	2.0	---	---	---	1.1E-01
Maintenance shop (not other shops)	1946-1954	0.50	0.40	2.0	0.50	0.50	5.2	---	---	---	2.0E-01
Maintenance shop (not other shops)	1955-1957	0.50	0.40	2.0	0.50	0.50	2.0	---	---	---	1.1E-01
Ore grinder/miller	1946-1955	0.75	0.40	2.0	0.25	0.50	39	---	---	---	6.6E-01
Ore Room/Warehouse worker, general	1946-1954	0.50	0.40	2.0	0.40	0.50	40	0.10	1.00	850	1.1E+01
Ore Room/Warehouse worker, general	1955-1957	0.50	0.40	2.0	0.50	0.50	4	---	---	---	1.7E-01
Process workers not otherwise listed, e.g., porters	1946-1954	0.75	0.40	2.0	0.25	0.50	40	---	---	---	**6.7E-01**
Process workers not otherwise listed, e.g., porters	1955-1957	0.75	0.40	2.0	0.25	0.50	4.0	---	---	---	**1.3E-01**
Recovery area worker	1946-1954	0.50	0.40	2.0	0.50	0.50	16	---	---	---	5.3E-01
Recovery area worker	1955-1957	0.50	0.40	2.0	0.50	0.50	2.0	---	---	---	1.1E-01
Scalehouse worker	1946-1950	0.50	0.40	2.0	0.40	0.50	158	0.10	1.00	273	7.1E+00
Scalehouse worker	1951-1954	0.50	0.40	2.0	0.40	0.50	6.3	0.10	1.00	273	3.5E+00
Scalehouse worker	1955-1957	0.50	0.40	2.0	0.25	0.50	6.3	0.25	1.00	24	8.6E-01
Supervisors and foremen	1946-1954	0.75	0.40	2.0	0.25	0.50	40	---	---	---	6.7E-01
Supervisors and foremen	1955-1957	0.75	0.40	2.0	0.25	0.50	4.0	---	---	---	1.3E-01
Plant 6E											
Process or maintenance worker	1950-1957	1.00	0.40	2.0	---	---	---	---	---	---	9.6E-02
Plant 7											
Process or maintenance worker	1950-1957	1.00	0.40	2.0	---	---	---	---	---	---	9.6E-02

Table 30 (Continued)

Worker type	Years	General areas			Ore/K-65 open areas			Enclosed work areas			Annual Intake, WLM
		Occ Factor	Equil Factor	Radon, pCi/l	Occ Factor	Equil Factor	Radon, pCi/l	Occ Factor	Equil Factor	Radon, pCi/l	
Plant 7E											
Plant 7E ionium (thorium) operator	1955-1957	0.50	0.40	2.0	0.50	0.50	100	---	---	---	3.0E+00
SLAPS*											
Bulldozer operator/crane operator (yard workers)	1946-1949	0.20	0.40	408	---	---	---	---	---	---	3.9E+00
Bulldozer operator/crane operator (yard workers)	1950-1958	0.20	0.40	2	---	---	---	---	---	---	1.9E-02
Forktruck driver (yard worker)	1946-1949	0.013	0.40	719	0.025	0.50	1160	0.025	1.00	1160	5.7E+00
Guard, full-time	1946-1949	1.00	0.40	81	---	---	---	---	---	---	3.9E+00
Guard, full-time	1950-1951	1.00	0.40	2	---	---	---	---	---	---	9.6E-02
Guard, part-time	1952-1958	0.05	0.40	2	---	---	---	---	---	---	4.8E-03
Guard, part-time	1959-1962	0.025	0.40	2	---	---	---	---	---	---	2.4E-03
Warehouse/K-65 worker (K-65)	1946-1949	---	---	---	0.10	0.50	1160	0.05	1.00	1160	1.4E+01

The intakes above should be applied only for applicable years (July 1955-March 1957 for Plant 7E) and ratioed for the appropriate year fractions. As a default, 0.096 WLM/yr should be used for process workers and 0.048 WLM/yr for all others and a whole year should be assumed. Note that the breaks in years corresponded to events that altered radon exposure, such as the processing of the K-65 from SLAPS and the cessation of sending it there.

The radon daughter equilibrium factor was taken to be 0.4 in the case of general areas far from a radon source or very open areas (this was used in all areas in ORAUT 2004); 0.5 in the case of radon-prone but relatively well-ventilated or unenclosed areas (this was used for all areas in Applied Nuclear Safety 1986 and Applied Nuclear Safety 1991); and 1.0 in the case of areas enclosed for long periods, such as railcars and the SLAPS sheds.

* It is not always possible to identify which workers worked wholly at Plant 6 and which spent part of their time at SLAPS; in any case, the SLAPS time constituted only a fraction of the total time of an applicable Plant 6 worker. Hence workers whose job titles fall in both Plant 6 and SLAPS in a given time period should be assigned both the Plant 6 and the SLAPS intakes (i.e., the sum) as their total annual intake.

Table 31A. Annual ingestion intakes, Plants 1 and 2, 1942-1945.

Job title	Intake, pCi/yr
Barium operator	3.92E+02
Boiler/Ether House/Nitric acid operator	1.00E+04
Centrifuge/wash filter operator	1.24E+05
Chemist (generic)	5.34E+04
Cloth operator	1.45E+05
Crafts: Carpenter/Pipefitter/Welder	2.75E+04
Digest/Extraction/Reduction operator	1.50E+05
Dispensary: Nurse/Medic/Other (personnel)	3.82E+04
Engineer (research or chemical)	1.00E+04
Feinc/Feed operator	2.14E+05
Foreman//Technical supervisor	3.51E+04
Furnace operator	5.40E+06
Guard/Chief guard	6.98E+03
Health/Safety field personnel	1.00E+04
Health/Security office personnel	3.27E+03
Instrument Shop machinist/technician	5.49E+04
Laboratory (generic)	5.34E+04
Laboratory office personnel	2.18E+04
Laboratory personnel (chemist, technician)	5.34E+04
Maintenance supervisor	1.09E+04
Manufacturing (generic)	1.45E+05
Mechanic/Area mechanic	4.12E+04
Miller ($UO_{3/}$QM-2)	2.75E+06
Office (generic)	1.09E+04
Office, administrative: Clerk/Office maintenance/Messenger/Porter/AEC	1.09E+04
Office, Production and Receiving: Bookkeeper*	6.26E+04
Office, Production and Receiving: Clerk/Secretary	3.51E+04
Ore Area/Room operator	2.99E+06
Pot Room operator	1.69E+06
Production superintendent/Asst production superintendent	5.45E+03
QM-2 (orange) loader	1.16E+06
QM-2 (orange) packager	3.05E+05
Raffinate/Sump operator	5.95E+04
Stockroom foreman/clerk	4.58E+03
Truck/forktruck operator/driver	1.64E+04
UO_2/LF-9/Brown packager/unloader	8.50E+06
Warehouse foreman/assistant foreman/warehouseman/railcar handling	4.27E+04
Workman (generic)	1.45E+05

* The “bookkeeper” title in early film badge records appears to indicate a production area accountability clerk, not an office worker. Thus 25% production area access is assumed.

Table 31B. Annual ingestion intakes, Plant 4, October 1942-1958.

Job title	Intake, pCi/year								
	Oct 1942 - 1946	1947	1948 - 1949	1950	1951	1952 - 1953	1954 - 1955	1956	1957-1958
Blender/Bomb makeup	6.56E+05	6.56E+05	6.56E+05	4.58E+04	1.40E+04	1.40E+04	7.19E+03	1.85E+04	---
Bomb charger/ Charger	6.56E+05	6.56E+05	6.56E+05	4.58E+04	1.40E+04	1.40E+04	7.19E+03	1.85E+04	---
Cage operator/man	7.94E+05	7.94E+05	7.94E+05	4.14E+04	---	---	---	---	---
Carpenter/Other craft	3.05E+04	3.05E+04	3.05E+04	1.83E+04	3.27E+03	3.27E+03	4.80E+03	4.80E+03	---
Casting operator	1.11E+06	1.98E+05	2.14E+05	3.05E+04	1.05E+05	1.05E+05	2.40E+04	2.40E+03	---
Charge firing (man)	2.03E+05	1.98E+05	2.14E+05	3.05E+04	---	---	---	---	---
Chemist/technician: miscellaneous	8.72E+03	8.72E+03	8.72E+03	8.72E+03	1.53E+03	1.53E+03	2.18E+03	2.18E+03	---
Chemist/technician: vacuum fusion	---	---	---	---	---	1.29E+04	1.29E+04	1.29E+04	---
Chipper	4.12E+05	4.12E+05	1.98E+05	3.05E+04	3.05E+04	3.05E+04	3.05E+04	3.05E+04	3.05E+04
Cleanup man	4.12E+05	4.12E+05	1.98E+05	3.05E+04	3.05E+04	3.05E+04	3.05E+04	3.05E+04	3.05E+04
Dingot lead operator	2.03E+05	1.37E+05	1.22E+05	7.63E+03	4.14E+03	4.14E+03	1.79E+03	4.14E+03	---
Dingot operator	6.56E+05	6.56E+05	6.56E+05	4.58E+04	1.40E+04	1.40E+04	7.19E+03	1.85E+04	---
Derby unloader	7.63E+04	6.10E+04	2.75E+05	3.82E+04	---	---	---	---	---
Engineer/Technical supervisor	3.82E+04	3.82E+04	3.82E+04	1.22E+04	2.62E+03	2.62E+03	2.18E+03	5.01E+03	---
Foreman/Shift foreman	3.82E+04	3.82E+04	3.82E+04	1.22E+04	2.62E+03	2.62E+03	2.18E+03	5.01E+03	---
Forge press operator/manipulator	---	---	---	---	---	5.01E+03	5.01E+03	5.01E+03	---
Furnace and saw man	---	---	---	---	3.92E+03	3.92E+03	3.92E+03	3.92E+03	---
Furnace loader (UF_4-derby)	7.32E+05	7.32E+05	4.88E+05	6.10E+04	---	---	---	---	---
Furnace (recast) operator	1.11E+06	1.98E+05	2.14E+05	3.05E+04	1.05E+05	1.05E+05	2.40E+04	2.40E+03	---
Furnace puller	2.03E+05	1.37E+05	1.22E+05	7.63E+03	4.14E+03	4.14E+03	1.79E+03	4.14E+03	---
Furnace tender	1.22E+05	1.22E+05	7.63E+04	1.53E+04	---	---	---	---	---
Guard/Chief guard	6.10E+03	6.10E+03	6.10E+03	6.10E+03	6.10E+03	1.26E+03	5.89E+02	1.55E+03	---
HF (fluorination) operator	1.24E+05	1.24E+05	1.24E+05	1.53E+04	---	---	---	---	---
Jolter	7.63E+05	7.63E+05	1.07E+05	1.53E+04	---	---	---	---	---
KB-2 lead operator	2.03E+05	1.37E+05	1.22E+05	7.63E+03	4.14E+03	4.14E+03	1.79E+03	4.14E+03	---
KB-2/Derby production (generic for reduction operations)	2.03E+05	1.98E+05	2.14E+05	3.05E+04	1.40E+04	1.40E+04	7.19E+03	1.85E+04	3.05E+04
Laboratory: ceramics/microscopy	---	---	---	---	3.92E+03	3.92E+03	3.92E+03	3.92E+03	---
Lime blender/Magnesium operator	1.53E+04	1.53E+04	1.53E+04	7.63E+03	---	---	---	---	---
Manufacturing (generic)	2.03E+05	1.98E+05	2.14E+05	3.05E+04	4.14E+03	4.58E+03	5.01E+03	4.80E+03	3.05E+04
Mechanic/Area mechanic	7.63E+04	7.63E+04	7.63E+04	1.83E+04	3.27E+03	3.27E+03	4.80E+03	4.80E+03	---
Miller-mixer (UF_4/TA-7)	1.02E+06	1.02E+06	2.14E+05	1.53E+04	---	---	---	---	---
Office: Plant superintendent/ Clerk/Other	9.16E+03	9.16E+03	9.16E+03	9.16E+03	9.16E+03	1.26E+03	5.89E+02	1.59E+03	---
Ore miller/handler	1.57E+05	---	---	---	---	---	---	---	---
Porter	2.44E+04	2.44E+04	2.44E+04	1.22E+04	1.22E+04	1.26E+03	5.89E+02	8.72E+03	---
Residue man	---	---	---	---	---	---	6.10E+03	6.10E+03	---
Salt bath man/Vertical lathe operator	---	---	---	---	---	---	6.10E+03	6.10E+03	---
Saw operator/man	4.12E+05	4.12E+05	1.98E+05	3.05E+04	3.05E+04	3.05E+04	3.05E+04	3.05E+04	3.05E+04
Shipping & Receiving	2.75E+04	2.75E+04	2.75E+04	2.75E+04	3.27E+03	3.27E+03	4.80E+03	4.80E+03	---
Slag man/Slag grinding operator	3.05E+04	3.05E+04	4.58E+04	1.53E+04	---	---	---	---	---
TA-7 packager	1.57E+06	1.57E+06	1.57E+06	5.34E+04	---	---	---	---	---
TA-7 unloader (operator)	2.83E+06	2.83E+06	3.36E+05	4.58E+04	---	---	---	---	---
Top cleaner	1.02E+06	1.02E+06	2.14E+05	1.53E+04	---	---	---	---	---
Topper	1.83E+05	1.83E+05	5.04E+05	4.58E+04	---	---	---	---	---
Top seat man	1.11E+06	1.98E+05	2.14E+05	3.05E+04	1.05E+05	1.05E+05	2.40E+04	2.40E+03	---
UF4/TA-7/green production (generic)	5.59E+05	4.35E+05	1.69E+05	1.68E+04	3.71E+03	3.71E+03	3.29E+03	4.47E+03	---
UO_2/LF-9 loader/packer	9.16E+05	7.32E+05	4.88E+05	6.10E+04	---	---	---	---	---
YM-5 lead operator	2.03E+05	1.37E+05	1.22E+05	7.63E+03	4.14E+03	4.14E+03	1.79E+03	4.14E+03	---
YM-5/billet/dingot production (generic for recast operations)	7.26E+05	1.98E+05	2.14E+05	3.05E+04	1.40E+04	9.48E+03	6.10E+03	4.14E+03	---

Table 31C. Annual ingestion intakes, Plant 6, 1946-1958.

Job title	Intake, pCi/year							
	1946 - 1948	1949	1950	1951	1952	1953	1954	1955 - 1958
AEC engineer	---	---	---	1.53E+03	6.76E+03	2.16E+03	4.14E+03	4.14E+03
Barium operator	3.92E+02	3.92E+02	2.75E+04	3.14E+04	2.83E+04	8.28E+03	---	---
C-3 centrifuge/wash filter/adjustments operator	1.24E+05	1.24E+05	3.05E+04	3.05E+04	9.16E+04	1.37E+05	1.72E+04	1.72E+04
Cleanup man/utility operator	---	---	---	2.11E+04	2.11E+04	2.05E+04	2.81E+04	1.92E+04
Cloth operator	1.45E+05	1.45E+05	5.34E+04	5.34E+04	2.01E+04	4.14E+03	3.92E+03	3.92E+03
Cloth & Training Group lead operator/trainer	5.49E+05	5.49E+05	5.04E+04	5.04E+04	5.01E+03	5.45E+03	3.92E+03	3.92E+03
Clothes issue man	2.01E+04	2.01E+04	2.01E+04	2.01E+04	2.01E+04	2.05E+03	4.14E+03	3.92E+03
Crafts: Carpenter/Pipefitter/Welder	2.75E+04	2.75E+04	2.14E+04	6.10E+03	6.10E+03	6.10E+03	6.32E+03	5.23E+03
Decontamination man/U-con man*	2.16E+04	2.16E+04	2.16E+04	2.16E+04	1.31E+04	4.14E+03	4.80E+03	3.71E+03
Cloth/Digest/Reduction operator, Outside sampling	1.50E+05	1.50E+05	5.34E+04	8.07E+04	2.01E+04	8.94E+03	1.31E+04	4.80E+03
Dispensary: Nurse/Medic/Other (personnel)	3.82E+04	3.82E+04	1.22E+04	2.16E+04	9.16E+03	1.37E+03	7.63E+02	2.83E+02
Boiler/Ether Hse/Extraction/Nitric acid rec'y operator	1.00E+04	1.00E+04	2.16E+04	1.09E+04	9.59E+03	4.14E+03	2.40E+03	7.41E+03
Experimental Continuous Furnace (Pilot Plant project)	---	1.86E+06	1.86E+06	---	---	---	---	---
Feinc/Feed/Soluble feed operator	2.14E+05	2.14E+05	3.36E+04	3.82E+04	3.27E+04	2.18E+04	2.09E+04	8.94E+03
Foreman/General foreman/Shift foreman/ Technical supervisor	3.51E+04	3.51E+04	3.51E+04	2.09E+04	1.77E+04	6.54E+03	5.45E+03	4.14E+03
Furnace operator	5.40E+06	5.40E+06	3.05E+05	3.27E+04	2.09E+04	1.20E+04	7.19E+03	2.62E+03
Guard/Chief guard	6.98E+03	6.98E+03	6.98E+03	3.92E+02	4.80E+03	3.49E+03	3.05E+03	2.18E+03
Health/Security Office personnel; Engineer (MCW, chemical)	3.27E+03	3.27E+03	3.27E+03	1.53E+03	3.05E+03	3.27E+03	2.40E+03	1.77E+03
Health Office: health surveyor/plant monitor	1.00E+04	1.00E+04	1.00E+04	9.16E+03	3.05E+03	3.27E+03	3.49E+03	3.27E+03
Instrument Shop machinist/technician	5.49E+04	5.49E+04	1.11E+04	1.31E+04	8.72E+03	3.71E+03	9.59E+03	2.62E+03
Laboratory Office personnel	2.18E+04	2.18E+04	2.18E+03	1.22E+03	1.22E+03	1.22E+03	4.36E+02	9.16E+03
Laboratory: chemist/technician (generic/MCW/ Shotgun)	5.34E+04	5.34E+04	5.23E+03	5.45E+03	5.01E+03	6.54E+03	2.18E+03	9.16E+03
Laundry operator/lead operator	---	---	---	9.81E+02	4.14E+03	2.40E+03	4.14E+03	1.35E+03
Ledoux Lab technician/asst technician – raffinate, MgF_2	4.12E+04	4.12E+04	1.98E+04	9.16E+04	3.05E+04	8.50E+03	1.77E+03	5.89E+03
Ledoux Lab technician (K-65)	4.58E+05	4.58E+05	3.05E+05	4.14E+05	9.59E+04	5.89E+03	1.64E+03	4.58E+03
LF-9/brown/UO_2 packager/unloader	8.50E+06	8.50E+06	7.94E+04	7.63E+04	7.63E+04	---	---	---
Maintenance supervisor	1.09E+04	1.09E+04	1.09E+04	8.28E+03	9.16E+03	2.18E+03	2.83E+03	3.05E+04
Maintenance (generic)	4.12E+04	4.12E+04	5.89E+02	6.10E+03	6.10E+03	6.10E+03	6.32E+03	5.23E+03
Manufacturing/Mfg (generic)	2.14E+05	1.50E+05	5.19E+04	3.54E+04	2.83E+04	8.94E+03	7.19E+03	5.23E+03
Mechanic/Area mechanic: C-3, digest, feed, furnace, Ore Room, raffin., Ether/Nitric Acid House	4.12E+04	4.12E+04	5.89E+02	6.10E+03	6.10E+03	6.10E+03	6.32E+03	5.23E+03
Metal dissolver (#1, #2)	---	---	---	4.45E+04	4.45E+04	4.45E+04	4.45E+04	4.45E+04
Metal room sampler	---	---	---	9.16E+04	9.16E+04	9.16E+04	9.16E+04	9.16E+04
MgX operator	2.05E+04	2.05E+04	2.05E+04	2.05E+04	1.13E+04	1.48E+04	6.32E+03	6.32E+03
Miller (UO_3/QM-2)	2.75E+06	2.75E+06	---	---	---	---	---	---
Office (generic)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Office, MCW: Clerk/Office maintenance/ Messenger/Porter /Expeditor	1.09E+04	1.09E+04	1.09E+04	1.05E+04	1.05E+04	4.36E+03	3.71E+03	3.27E+03
Office: MCW - Other, AEC - all AEC except Engineer	1.09E+04	1.09E+04	1.09E+04	0.00E+00	1.46E+03	6.32E+02	4.80E+02	4.80E+02
Office, Production/Receiving: Clerk/Secretary	3.51E+04	3.51E+04	1.13E+04	2.16E+04	3.71E+03	3.92E+03	4.14E+03	1.98E+03
Ore Room operator***	2.99E+06	7.63E+04	8.55E+04	8.07E+04	3.71E+04	3.05E+04	3.05E+04	---
Pilot Plant engineer	2.68E+04	2.68E+04	1.16E+04	1.26E+04	8.50E+03	6.76E+02	1.50E+03	1.64E+03
Pilot Plant lead operator/group leader	5.34E+04	5.34E+04	2.29E+04	2.53E+04	1.68E+04	1.33E+03	1.92E+03	1.68E+03
Pilot Plant technician	5.34E+04	5.34E+04	2.29E+04	2.53E+04	1.68E+04	1.31E+03	2.01E+03	4.23E+05
Pot Room operator	1.69E+06	1.68E+05	7.32E+04	2.18E+04	4.14E+04	9.81E+03	2.46E+04	5.10E+04
Powder sample technician	6.87E+05	6.87E+05	4.73E+04	4.73E+04	1.24E+04	1.24E+04	1.24E+04	1.24E+04
Power House (generic)	1.00E+04	1.00E+04	2.16E+04	1.09E+04	9.59E+03	4.14E+03	2.40E+03	7.41E+03
Production Research Lab personnel	1.83E+04	1.83E+04	2.62E+03	6.54E+03	2.83E+03	1.09E+03	4.36E+02	8.07E+02
Production superintendent/Asst production superintendent	5.45E+03	5.45E+03	5.45E+03	5.45E+03	5.67E+03	1.22E+04	4.58E+03	3.92E+03
QM-2 (orange) loader	1.16E+06	1.16E+06	3.05E+05	9.16E+04	9.16E+04	9.16E+04	---	---
QM-2 (orange) packager	3.05E+05	3.05E+05	3.05E+05	9.16E+04	2.83E+04	2.83E+04	2.62E+04	---
Raffinate/Sump recovery operator	5.95E+04	5.95E+04	3.36E+04	1.66E+04	3.71E+04	1.85E+03	2.40E+03	4.71E+04
Sample Room supervisor	9.77E+04	9.77E+04	5.34E+04	5.34E+04	5.34E+04	8.94E+03	8.94E+03	8.94E+03
Stockroom foreman/clerk	4.58E+03	4.58E+03	4.58E+03	7.19E+03	3.27E+03	7.41E+03	3.05E+03	8.07E+02

Table 31C (Continued)

Job title	Intake, pCi/year							
	1946 - 1948	1949	1950	1951	1952	1953	1954	1955 - 1958
Storeroom (generic)	4.58E+03	4.58E+03	4.58E+03	7.19E+03	3.27E+03	7.41E+03	3.05E+03	8.07E+02
Truck/forktruck operator/driver	1.64E+04	1.64E+04	1.64E+04	1.64E+04	1.37E+04	4.36E+03	4.14E+03	4.36E+03
Warehouse (generic)	4.27E+04	4.27E+04	1.83E+04	1.53E+04	8.28E+03	4.36E+03	2.18E+03	1.26E+03
Warehouse foreman/assistant foreman/ warehouseman	4.27E+04	4.27E+04	1.83E+04	1.53E+04	8.28E+03	4.36E+03	2.18E+03	1.26E+03
Warehouse K-65 sampler/weighmaster	4.27E+04	4.27E+04	1.83E+04	5.01E+04	5.89E+04	7.63E+04	7.63E+04	---

Table 31D. Annual ingestion intakes, Plant 6E, 1950-1958.

Job title	Intake, pCi/year				
	Oct 1950 - Dec 1952	1953	1954	1955	1956 -1958
Area mechanic	5.01E+03	5.01E+03	5.01E+03	7.85E+03	1.59E+04
Billet grinder	7.41E+03	7.41E+03	7.41E+03	9.27E+04	1.46E+05
Blender; Lime/slag blender	1.94E+03	3.04E+03	2.83E+03	2.40E+03	1.24E+03
Bottom furnace operator	1.48E+04	6.76E+03	2.57E+04	2.33E+04	8.94E+03
Bottom/Lower “F” machine operator	5.01E+03	3.27E+03	5.23E+03	1.13E+04	6.32E+03
Breakout operator/man	5.45E+03	7.09E+03	6.10E+03	9.16E+03	5.01E+03
Brushing man	---	---	---	1.02E+04	1.02E+04
Burnout man	3.49E+04	5.67E+03	5.01E+03	6.76E+03	8.50E+03
Cage grinding/cage operator/man	1.20E+04	2.41E+04	4.36E+03	7.63E+03	7.61E+04
Cage/4th saw man	3.71E+03	1.74E+04	4.58E+03	8.28E+03	8.28E+03
Capping man/capper	1.77E+04	1.10E+04	6.76E+03	6.98E+03	9.16E+03
Chipper/Derby chipper	4.60E+05	4.60E+05	4.60E+05	4.60E+05	4.14E+03
Crafts: Maintenance/electrician/mechanic/millwright; Graphite Shop	9.81E+03	8.61E+03	5.01E+03	7.85E+03	1.59E+04
Crucible assembler	1.77E+04	1.10E+04	6.76E+03	6.98E+03	9.16E+03
Crucible loader	6.10E+03	1.89E+04	1.07E+04	4.14E+03	1.31E+04
Decontamination operator/man	4.58E+03	4.58E+03	6.54E+03	7.41E+03	5.67E+03
Engineer/Chemical engineer/Technical engineer	5.89E+03	2.94E+03	3.27E+03	5.23E+03	1.24E+03
Extra man	8.07E+03	9.59E+03	7.19E+03	8.28E+03	1.09E+04
F (machine) charger	8.07E+03	9.59E+03	7.19E+03	8.28E+03	1.09E+04
Foreman, Assistant/General	4.36E+03	2.73E+03	4.14E+03	5.89E+03	1.33E+03
Foreman, Shift	9.81E+03	8.72E+03	5.67E+03	7.85E+03	5.89E+03
Furnace (recast) operator/unloader	1.48E+04	6.76E+03	2.57E+04	2.33E+04	8.94E+03
Furnace (recast) unloader	1.48E+04	6.76E+03	2.57E+04	2.33E+04	8.94E+03
Furnace (reduction) loader	3.27E+03	4.25E+03	5.01E+03	5.01E+03	5.01E+03
Jolter	6.10E+03	1.06E+04	1.00E+04	2.46E+04	5.23E+03
KB-2/derby production (generic for reduction operations)	6.10E+03	8.72E+03	6.10E+03	8.72E+03	5.23E+03
Lead operator (generic)	1.48E+04	6.76E+03	2.57E+04	2.33E+04	8.94E+03
Lift truck driver (operator)	6.54E+03	3.16E+03	3.71E+03	4.80E+03	1.74E+03
Office employees/Clerk; Production clerk	2.83E+03	3.38E+03	1.70E+03	3.05E+03	2.07E+03
Porter	9.81E+03	8.72E+03	5.67E+03	7.85E+03	5.89E+03
Production machinist	8.28E+04	2.94E+03	1.64E+03	2.40E+03	1.53E+03
Recast furnace/YM-5 lead operator	1.07E+04	4.36E+03	1.02E+04	6.54E+03	1.55E+04
Reduction furnace operator	3.27E+03	4.25E+03	5.01E+03	5.01E+03	5.01E+03
Reduction/KB-2 lead operator	9.81E+03	8.72E+03	5.67E+03	7.85E+03	5.89E+03
Residue man (dust collector work)	1.44E+04	3.16E+04	2.51E+04	6.54E+04	5.23E+03
Saw operator/man	6.54E+03	7.19E+03	7.41E+03	9.27E+04	2.83E+03
Slag building operator	2.40E+04	2.40E+04	2.40E+04	4.88E+04	3.92E+03
Superintendent/Supervisor	5.89E+03	2.94E+03	3.27E+03	5.23E+03	1.24E+03
Top/upper furnace operator	4.58E+03	4.58E+03	6.54E+03	7.41E+03	5.67E+03
Top/Upper/Generic “F” machine operator; Top(-ping) operator	6.10E+03	1.06E+04	1.00E+04	2.46E+04	5.23E+03
Utility operator (sump recovery; extra hand)	8.07E+03	9.59E+03	7.19E+03	8.28E+03	1.09E+04
YM-5/billet production (generic for recast operations)	1.07E+04	6.76E+03	7.41E+03	7.85E+03	8.94E+03

Table 31E. Annual inhalation intakes, Plant 7, 1951-1958.

Job title	Intake, pCi/year					
	1951	1952	1953	1954	1955	1956 - 1958
Area mechanic	8.07E+03	3.05E+03	8.07E+03	1.53E+03	2.83E+03	3.05E+03
Clerk/Record clerk; Porter	4.80E+03	4.58E+03	2.18E+03	2.83E+03	6.98E+03	6.98E+03
Decontamination man/Decontaminator	3.51E+04	4.58E+03	2.62E+03	1.96E+03	3.71E+03	3.92E+03
Engineer	4.80E+03	4.58E+03	2.18E+03	1.53E+03	1.53E+04	6.98E+03
Filter/Tables operator*	---	---	---	---	1.96E+03	1.96E+03
Foreman, Asst	4.80E+03	4.58E+03	2.18E+03	1.53E+03	1.53E+04	6.98E+03
Foreman	6.10E+03	6.10E+03	4.80E+03	2.62E+03	3.49E+03	3.92E+03
Furnace operator	5.45E+03	6.10E+03	1.46E+04	5.01E+03	3.92E+03	3.71E+03
HF Room/Magnesium Room operator	1.74E+03	3.05E+03	1.96E+03	1.09E+03	1.09E+03	1.16E+03
Hoisting (slag) operator*	---	---	---	---	3.27E+03	3.27E+03
Lead (UF_4/TA-7) operator	8.28E+03	4.58E+03	3.71E+03	1.96E+03	6.54E+03	6.54E+03
Lift truck driver (operator)	3.05E+03	3.05E+03	2.18E+03	3.05E+03	5.67E+03	8.94E+03
Panel board/36' level operator	8.28E+03	4.58E+03	3.71E+03	1.96E+03	6.54E+03	6.54E+03
Plant superintendent	4.80E+03	4.58E+03	2.18E+03	1.53E+03	1.53E+04	6.98E+03
UO_3/QM-2 dumper/hoister	2.33E+04	1.22E+04	1.33E+04	9.16E+03	1.37E+04	2.44E+04
Safety clerk	3.71E+03	3.71E+03	3.71E+03	1.96E+03	3.05E+03	3.05E+03
Safety inspector/Fire marshal	6.10E+03	6.10E+03	4.80E+03	2.62E+03	3.49E+03	3.92E+03
Sampler and cleanup man	---	6.10E+03	6.23E+04	1.74E+03	1.74E+03	1.98E+03
Supervisor, Technical	6.10E+03	6.10E+03	4.80E+03	2.62E+03	3.49E+03	3.92E+03
TA-7 hoisting operator (hoister)	2.64E+04	3.05E+03	2.83E+03	2.83E+03	2.40E+03	3.71E+03
TA-7 (green/UF_4) packager	5.28E+04	6.10E+03	2.25E+04	1.48E+04	1.07E+04	5.23E+03
UF4/TA-7/Green production (generic for UF4 production operations)	8.28E+03	4.58E+03	8.07E+03	2.83E+03	3.92E+03	3.71E+03
Utility operator	5.45E+03	6.10E+03	1.46E+04	5.01E+03	3.92E+03	3.71E+03
Welder	8.07E+03	3.05E+03	8.07E+03	1.53E+03	2.83E+03	3.05E+03

Table 31F. Annual inhalation intakes, Plant 7E.

Job title	Intake, pCi/year		
	1954	1955	1956 - 1957
Plant 7E (thorium/ionium concentration process)			
Ionium plant operator/lead operator*	---	2.18E+01	6.54E+01

* The thorium/ionium (concentration) plant work began after July 1955 and continued until March 1957; thus the annual intakes here should be ratioed by the appropriate number of months worked (i.e., a maximum of 6 in 1955, 12 in 1956, and 3 in 1957). The ionium case should use the isotopic breakdown given in Section 6.1, Item 5.

Table 32. Exposure rates from K-65 residue and Q-11 ore, in mR/hr (AEC 1949b, Figure 21).

Source	Position	Distance, feet	Dose rate	Dose rate A	Dose rate B	Dose rate C
96 drums of K-65, along the full width of a railcar and ~46 ft along its length (57 ft)	Drum group centerline perpendicular to long side of railcar, 4 ft from ground	1	85			
		3	72.5			
		5	50			
		8	37.5			
		12	27			
		18	19			
		24	12.5			
		30	9.4			
	Top of railcar	Contact	104			
87 drums of Q-11, distributed in two groups at ends of railcar	One drum group centerline perpendicular to long side of railcar (A); at center door (B); at end (C)	2		37	7.75	24
		4		24	8.75	
		6		18	9	9.5
		8		16	9.5	
		10		14	9.7	6.6
		12		12	9.7	
		14		10.5	9.5	5.5
		16		9	8.5	
	Top of railcar, over one group (A); over empty center (B)	Contact		21	11	
5 railcars in a row containing unspecified amount of K-65	Along a line perpendicular to the axis of the line of railcars, even with the center of the middle car	10	50			
		25	22			
		43	13			
		50	10.2			

The total length of a railcar was given as 57 feet.

Table 33. Measured dose rates in various work areas.

	Exposure, % tolerance	Exposure, mrep/hr or mR/hr*	Year	Reference
PLANTS 1 and 2				
Soda salt, near-contact: gamma; beta	20; 20	2.5; 13	1943	MED 1944f
Soda salt, 6": gamma; beta	10; 20	1.2; 13	1943	MED 1944f
Vanadium sludge, over 1 month old, 10 cm from 216 jar: gamma; beta	1.5; 20	.19; 13	1943	MED 1944f
High-grade pitchblende ore, 55-gal drum, 1000 lbs ore: 60"		3.8	1945	Rochester 1945
High-grade pitchblende ore, 55-gal drum, 1000 lbs ore: 45"		6.1	1945	Rochester 1945
High-grade pitchblende ore, 55-gal drum, 1000 lbs ore: 30"		12	1945	Rochester 1945
High-grade pitchblende ore, 55-gal drum, 1000 lbs ore: 15"		29	1945	Rochester 1945
High-grade pitchblende ore, 55-gal drum, 1000 lbs ore: 6"		66	1945	Rochester 1945
High-grade pitchblende ore, 55-gal drum, 1000 lbs ore: contact		100	1945	Rochester 1945
High-grade pitchblende ore, 15-gal drum, 443 lbs ore: 60"		2.4	1945	Rochester 1945
High-grade pitchblende ore, 15-gal drum, 443 lbs ore: 45"		3.6	1945	Rochester 1945
High-grade pitchblende ore, 15-gal drum, 443 lbs ore: 30"		7.1	1945	Rochester 1945
High-grade pitchblende ore, 15-gal drum, 443 lbs ore: contact		90	1945	Rochester 1945
Ether extraction tanks	25	3.1	1943	MED 1944f
Residue drier (beta only)	120	75	1943	MED 1944f
"SM sub 2": gamma; beta	42; 40	5.2; 25	1943	MED 1944f
"SN sub 4": gamma only	30	3.8	1943	MED 1944f
"SB sub 3": gamma; beta	35; 40	4.4; 25	1943	MED 1944f
Tank 1A cake from SN sub 2: gamma; beta	10; 120	1.2; 13	1943	MED 1944f
Tank 7 press cake, 10 days old, 10 cm from the edge: gamma; beta	20; 400	2.5; 250	1943	MED 1944f
308 [material] from Tank 7 press cake residue, 10 days old: beta only	400	250	1943	MED 1944f
Residue Chem. 4217, 2 months old, 10 cm from 2-lb bottle: gamma; beta	5; 30	.62; 10	1943	MED 1944f
Over top of Shed #1 recovery cake: gamma, beta	12; 30	1.5; 19	1943	MED 1944f
Acid press cake from tank treatment, 10" above: gamma; beta	---	6.3; 300	1944	MED 1945b
Barrel of residue after storage for 6 months, top: gamma; beta	---	6.2;50	1944	MED 1945b
Barrel of residue after storage for 6 months, 6' from side: gamma, beta	---	6.2; 75	1944	MED 1945b
Caustic precipitate before it enters the drier, 5-6": gamma; beta	---	6.2, 450	1944	MED 1945b
Plate of residue being dried in oven, 3", beta only	---	250	1944	MED 1945b
Trays in drier, pile, in which NG & SNG residues are dried: 2 " above: gamma; beta	---	5; 50	1944	MED 1945b
Trays in the drier, along the axis about 1': gamma, beta	---	6.2, 250	1944	MED 1945b
Flat dish of residue on top of above crucible covering, 3": gamma; beta	---	0; 1000	1944	MED 1945b
Concrete crucible covering, residue cooling for 4 hours, 3" above: beta	---	400	1944	MED 1945b
Flat dish of slag dust, 3", beta only	---	0	1944	MED 1945b
Floor of Hood #6, 4", where most 4th extractions spilled: gamma; beta	50; 30	6.2; 19	1944	MED 1944m
Most contaminated part of hood floor where shotgun samples dried: gamma; beta	70; 40	8.8; 25	1944	MED 1944m
Shotgun prep lab table top with daily change of brown paper, 4": gamma; beta	---	<13; <25	1944	MED 1945b
Lip of evaporating dish with 3rd-extraction liquor, .5": gamma; beta	50; 30	6.2; 19	1944	MED 1944m
Lip of evapor'g dish w/ 4th-extraction liquor, .5" away, 2" above liquor: gamma; beta	100; 600	13; 375	1944	MED 1944m
Lip of evaporating dish with shotgun sample, .5": gamma; beta	60; 100	7.5; 62	1944	MED 1944m
Lip of evaporating dish containing shotgun sample, 7": gamma; beta	30; 20	3.8; 13	1944	MED 1944m
Lip of evaporating dish containing 5.17-g shotgun sample, 10": beta only	20	13	1944	MED 1944m
Lip of evaporating dish, cleaned, that had held shotgun sample, .5": gamma; beta	30; 20	2.5; 25	1944	MED 1944m
3.36 g shotgun sample, 3" above: gamma; beta	200; 1600	25; 1000	1944	MED 1944m
5.15 g shotgun sample in bottom of evaporating dish, 4": gamma; beta	130; ---	16; >375	1944	MED 1944m
4.31 g shotgun sample, 7": gamma; beta	100; 400	13; 250	1944	MED 1944m
5.15 g shotgun sample in bottom of evaporating dish, 7": beta only	700	440	1944	MED 1944m
5.15 g shotgun sample in bottom of evaporating dish, 11": beta only	340	215	1944	MED 1944m
5.15 g shotgun sample in dish, 11", through rubber glove: beta only	170	106	1944	MED 1944m
Surface of rubber glove above: beta only	20	13	1944	MED 1944m
Outside bottom of evaporating dish with 3.36 g sample, .5": gamma; beta	50; 140	6.2; 88	1944	MED 1944m
Bottom of cleaned evaporating dish (had held shotgun sample), 2": gamma; beta	20; 40	2.5; 25	1944	MED 1944m
Glass shipping bottle with 3.08-g shotgun sample, 1": gamma; beta	60; 100	7.5; 62	1944	MED 1944m
Shotgun package containing three bottles: gamma; beta	---	2.5; 0	1944	MED 1945b
Bottom of package with 5 shotgun samples to be shipped, 2": gamma; beta	100; 0	13; 0	1944	MED 1944m

Table 33 (Continued)

	Exposure, % tolerance	Exposure, mrep/hr or mR/hr*	Year	Reference
PLANT 4				
Sublining material, 6" from pail: gamma; beta	42; >400	5.2; >250	1943	MED 1944f
Insulating brick from recast furnace: beta only	>400	>250	1943	MED 1944f
Freshly cast metal: beta only	10	6.2	1943	MED 1944f
Green salt, form normally handled, 1": beta only	---	100	1944	MED 1945b
Green salt, contact with tray of green salt: beta only	---	108	1948	MCW 1948a
Green salt, exposure to any large surface (tray, open can, etc), 1': beta only	---	64	1948	MCW 1948a
Above bench on which green salt is packed, 4": gamma, beta	---	<13; <25	1944	MED 1945b
Bomb step, exposure to large surfaces of green salt, 1': beta only	---	50	1948	MCW 1948b
Bomb step, loading bomb, full bomb, 1': beta only	---	53	1948	MCW 1948b
Bomb step, unloading bomb, knockout grate, 1': beta only	---	3.6	1948	MCW 1948a
Bomb step, at edge of unloader jolter, 1': beta only	---	3	1948	MCW 1948a
Top of table where ingot is pushed out of bomb, beta only	---	100	1944	MED 1945b
Bomb step, derby transport table, 1': beta only	---	5.3	1948	MCW 1948a
Bomb step, contact with unchipped derby: beta only	---	116		MCW 1948a
Bomb step, chipping, 1' (chipper location): beta only	---	42	1948	MCW 1948a
Top of chipper's table, beta only	---	125	1944	MED 1945b
Contact with the chipper's table: beta only	---	465	1948	MCW 1948a
Ingot storage room, 4' from pile of ripe metal, beta only	---	25	1944	MED 1945b
Ingot storage and packing room, 3' from ore scrap pile in crib, beta only	---	25	1944	MED 1945b
Recasting step, cleaning crucible lids and stoppers, 1' above tray: beta only	---	3000	1948	MCW 1948B
Recasting step, cleaning crucible lids and stoppers, chest high: beta only	---	280	1948	MCW 1948a
Recasting furnace platform, 6" above, beta only	---	168	1944	MED 1945b
Recasting step, above top of furnace immediately after opening, 1': beta only	---	1450	1948	MCW 1948a
Recasting step, above top of furnace, baffle & crucible lid removed, 1': beta only	---	650	1948	MCW 1948a
Recasting step, contact with cleaned crucible lid: beta only	---	155	1948	MCW 1948a
Recasting step, chest high while cleaning top of furnace: beta only	---	135	1948	MCW 1948a
Recasting step, cleaning furnace top, edge of top cleaning hood: beta only	---	220	1948	MCW 1948a
Recasting step, inside bottom of furnace before removing rolls, 1': beta only	---	12	1948	MCW 1948a
Recasting step, inside bottom of furnace after cleaning, 1': beta only	---	16	1948	MCW 1948a
Recasting step, average for general area of bottom furnace work: beta only	---	16	1948	MCW 1948a
Recasting step, above drum of D-7, 1': beta only	---	140	1948	MCW 1948a
Recasting step, above D-7 table, 1': beta only	---	270	1948	MCW 1948a
Billets stored by desk and scale, gamma+beta		90-270	1953	MCW 1953e
Saw with no uranium billet in it, gamma+beta		100-150	1953	MCW 1953e
Empty furnace, lid off, top center//edge//1 foot, gamma+beta		300-400//100//70	1953	MCW 1953e
Furnace lid and brush, center//edge, gamma+beta		1200//100	1953	MCW 1953e
Furnace bottom plate (operator foot position), gamma+beta		800	1953	MCW 1953e
Empty furnace, bottom opening, edge//1 foot, gamma+beta		300//100-250	1953	MCW 1953e
Used crucible before loading		380	1953	MCW 1953e
Sample storage room (Plant 4), beta only	---	25	1944	MED 1945b
Storage and packaging, average for general area: beta only	---	3	1948	MCW 1948a
Storage and packaging, facing table of derbies, 1' above table edge: beta only	---	21	1948	MCW 1948a
Storage and packaging, surface of cleaned derby: beta only	---	85	1948	MCW 1948a
Storage and packaging, box of rolls, 1' above: beta only	---	5	1948	MCW 1948a
Slag from reaction bomb, 4", beta only	---	250	1944	MED 1945b
Bomb step, edge of the slag barrel: beta only	---	66	1948	MCW 1948a
Pile of slag in sample aging room, 2": gamma; beta	---	<25, 200	1944	MED 1945b
Piece of slag (~30 in3), 1.5": gamma; beta	---	2.5; 100	1944	MED 1945b
PLANT 6				
Ore barrels, direct contact with a group	---	200	1947	AEC 1947a
Ore drum, 4" away through 2" of steel(?) shielding	---	9.5	1948	AEC 1948a
Removing lids from ore drums, hands	---	25-38	1948	AEC 1948d
Ore milling feeder tube, 3" away, gamma	---	53	1948	AEC 1948a
Ore milling hopper general vicinity, first platform	---	15	1948	AEC 1948a
Ore milling hopper, 8" away through 1/8" steel plate shielding	---	40	1948	AEC 1948a
Ore milling hopper, 3" away, first platform	---	20	1948	AEC 1948a
Ore milling hopper, 35" from revolving ore drum at first platform guardrail	---	7	1948	AEC 1948a
Ore milling gas blower, 15" from revolving ore drum	---	9.5	1948	AEC 1948a
By Tank M-2 on platform, 5 hrs after addition of 6000 lbs ore: 1 foot	100		1946	MCW 1946a

Table 33 (Continued)

	Exposure, % tolerance	Exposure, mrep/hr or mR/hr*	Year	Reference
By Tank M-2, on platform (catwalk): 6"; 18"; 36" from tank	230; 120; 90		1947	AEC 1949f
By Tank M-3 on platform while adding ore (2000 lbs in tank): 1 foot	70		1946	MCW 1946a
By Tank M-3, on platform (catwalk): 6"; 18"; 36" from tank	220; 120; 90		1947	AEC 1949f
Under Tank M-3, containing GLC: 1 foot	120		1946	MCW 1946a
By Tank M-4, on platform (catwalk): 6"; 18"; 36" from tank	80-200; 50-60; 40		1947	AEC 1949f
By Tank M-72, containing wash water: 1 foot	50		1946	MCW 1946a
By Tank M-1, on platform: about 250 gal GLC (3 days old), 1 foot	90		1946	MCW 1946a
By Tank M-1, on platform (catwalk): 6"; 18"; 36" from tank	220; 180; 90		1947	AEC 1949f
By Tank M-83: three-quarters full of GLC (2 days old), 1 foot	220		1946	MCW 1946a
By Tank M-83: 6" from tank	500		1947	AEC 1949f
At operator position between skid and Tank M-14, on platform: 1 foot	120		1946	MCW 1946a
Above skid of GLC on M-14: 1 foot	280		1946	MCW 1946a
Between Tanks M-14 and M-20, midway, on platform (catwalk)	350		1947	AEC 1949f
By Tank M-14, on platform (catwalk): 6"; 18"; 36" from tank	450; 400; 250		1947	AEC 1949f
By Tank M-19, on platform:reslurrying skid cake batch: 1 foot	120		1946	MCW 1946a
By Tank M-19, on platform: 18" from tank	300		1947	AEC 1949f
By Tank M-19, on top of tank: 1 foot	250		1946	MCW 1946a
In front of Feinc filter while filtering reslurry batch: 1 foot	210 (2)		1946	MCW 1946a
At Feinc filter GI-4/GI-9: front (walkway); side; back; top (all at 6")	400; 350; 500; 900		1947	AEC 1949f
Near Feinc filter, on platform: gamma min//avg//max		5//16//50	1948	MCW 1948E
Feinc cloth change, < 3 feet from Feinc: gamma, beta		30; 69	1951	MCW 1951a
Feinc cloth change, general vicinity: gamma, beta		12; Negligible	1951	MCW 1951a
Leach (cell) cloth change, < 3 feet: gamma, beta		16; 158	1951	MCW 1951a
Leach (cell) cloth change, general vicinity: gamma, beta		10; 40	1951	MCW 1951a
Wash (cell) cloth change, < 3 feet:gamma, beta		42; 150	1951	MCW 1951a
Wash (cell) cloth change, general vicinity: gamma, beta		17; 48	1951	MCW 1951a
Old material work in old cloth room: average gamma, beta		5; 20	1951	MCW 1951a
Carrying, laundering Feinc, Leach, & Wash cloths, old cloth room: gamma, beta		3; 25	1951	MCW 1951a
Carrying, repairing Feinc blankets, old cloth room: gamma, beta		6; 30	1951	MCW 1951a
Washing Feinc blanket with brush on floor: carrying//changing -- gamma, beta		28; 105//28; 150	1951	MCW 1951a
Changing strings, Feinc, Leach, and Wash filters in cells: typical gamma, beta		30;75	1951	MCW 1951a
Cloth storage room, gamma		0.3 - 2.0	1955	MCW 1957
Feinc filter plates (removed for cleaning, with some residue caked on them)		<1-5; <10	1950	MCW 1950b
Floor surface under Feinc platform: 1 foot	30 (8)		1946	MCW 1946a
Floor around Feinc filters: 1 foot	110 (7)		1946	MCW 1946a
Feinc filtrate residue, contact (gamma; beta)		>300; >500	1948	AEC 1948k
Operator position while filling drums of GLC: about 1 foot	110 (2)		1946	MCW 1946a
Skids of acid press cake (2-3 days old): 1 foot	200 (5)		1946	MCW 1946a
55-gal drum: 521 lbs of K-65 less than 24 hours old, side contact (gamma)	275		1949	MCW 1949g
GLC (3 days old), centered among 4 barrels; between 2 barrels	150; 120		1946	MCW 1946a
4 drums "aged" K-65, 6 feet	---	28	1947	AEC 1947c
2 drums "aged" K-65, 6 feet	---	23	1947	AEC 1947c
Sump recovery skids, all full (1 foot)	80 (5)		1946	MCW 1946a
Dempster body of Chem 6BC; Chem 6BP (1 foot)	30; 40		1946	MCW 1946a
Scalehouse sample room, sampling K-65: gamma; beta		2.0-4.0; 2.5-5.0	1955	MCW 1955n
Scalehouse sample room, carrying K-65 sample pans: gamma; beta		6.0; 12.5	1955	MCW 1955n
Sample Prep Room, pile of K-65 in hood: 1 foot	60		1946	MCW 1946a
Sample Prep Room, 3-gal bottle of K-65 at equilibrium; 3 2-qt bottles at equil (1 foot)	160; 100		1946	MCW 1946a
Sample Prep Room, operator position at Ro-Tap	50		1946	MCW 1946a
Sample Prep Room, operator position while milling GLC	130		1946	MCW 1946a
Sample Prep Room, near drying oven: 1 foot	20		1946	MCW 1946a
Laboratory sample room: center; vault	0; 80		1946	MCW 1946a
Analytical Lab, Dry Sample Prep Room, making up shotgun samples: gamma, beta	3; 1		1956	MCW 1956l
Shotgun Lab, scooping samples into vats: gamma, beta	3; 8		1956	MCW 1956l
Shotgun Lab, draining residue, 1st ether contact, max (NLO sample): gamma, beta	5; 8		1956	MCW 1956l

Table 33 (Continued)

	Exposure, % tolerance	Exposure, mrep/hr or mR/hr*	Year	Reference
Shotgun Lab, draining residue, later ether contacts, max: gamma, beta	6; 50		1956	MCW 1956l
Shotgun Lab, moving residue to hot plate, max: gamma, beta	6; 25		1956	MCW 1956l
Shotgun Lab, removing material from muffle furnace, max: gamma, beta	8; 30		1956	MCW 1956l
Shotgun Lab, removing material from mold, max: gamma, beta	8; 25		1956	MCW 1956l
Shotgun Lab, paint and place in box: gamma, beta	8; 10		1956	MCW 1956l
Shotgun Lab, counting samples: gamma, beta	2; 2		1956	MCW 1956l
Shotgun Lab, lab assay work	1.5; ND		1956	MCW 1956l
Shotgun Lab, general area work	1; ND		1956	MCW 1956l
Fork truck driver position while loading GLC(rail?)car	140		1946	MCW 1946a
UO_2 packing area, cylindrical boxes containing UO_2, cover on, beta	4.5		1948	Rochester 1948b
UO_2 packing area, cylindrical boxes containing UO_2, cover off, beta	22.5		1948	Rochester 1948b
UO_2 packing area, inside 55-gal drum half-filled with UO_2, beta	27		1948	Rochester 1948b
Warehouse, on 25 cylindrical boxes containing UO_2, cover on, beta	15		1948	Rochester 1948b
PLANT 6E				
Lid cleaner of the furnace enclosures: gamma, beta		170; 7500	1955	MCW 1955t
Crucible, large unpainted, contact: gamma, beta		5; 3000	1955	MCW 1955s
Crucible, large painted, contact: gamma, beta		4; 1000	1955	MCW 1955s
Crucible, small unpainted, contact: gamma, beta		4; 700	1955	MCW 1955s
Crucible, small painted, contact: gamma, beta		2; 560	1955	MCW 1955s
Painting used crucible: gamma, beta		1; 300	1955	MCW 1955s
Painting used crucible, body or arm: gamma, beta		2; 500	1956	MCW 1956k
Painting used crucible, hand: gamma, beta		4; 1500	1956	MCW 1956k
Assembling used crucible: gamma, beta		1; 70	1955	MCW 1955s
Assembling crucible, body at enclosure armhole: gamma, beta (mR/wk, mrep/wk)		36; 2500	1956	MCW 1956n
Assembling crucible, body: gamma, beta		2; 200	1956	MCW 1956k
Assembling crucible, arm: gamma, beta (in mR/week, mrep/week)		74; 17500	1956	MCW 1956n
Assembling crucible, arm: gamma, beta		6; 1800	1956	MCW 1956k
Assembling crucible, hand: gamma, beta (in mR/week, mrep/week)		78; 25000	1956	MCW 1956n
Assembling crucible, hand: gamma, beta		4; 1500	1956	MCW 1956k
General crucible assembly area: gamma, beta		ND; 30	1955	MCW 1955s
General crucible assembly area work: gamma, beta		0.5; 3	1956	MCW 1956k
Crucible assembly operator, wrist: gamma, beta (mR/day, mrep/day)		50; 740	1956	MCW 1956m
Adjusting crucible jack: gamma, beta		1; 25	1956	MCW 1956k
Assembled used crucible, before loading: gamma, beta		1; 20	1955	MCW 1955s
Loading high-carbon/CST, max, body: gamma, beta		1; 20	1956	MCW 1956k
Loading high-carbon/CST, max, arm: gamma, beta		2; 120	1956	MCW 1956k
Loading high-carbon/CST, max, hand: gamma, beta		6; 300	1956	MCW 1956k
Loading crucible: gamma, beta		1; 20	1955	MCW 1955s
Lining up crucible: gamma, beta		1; 48	1955	MCW 1955s
Handling crucible lid: gamma, beta		1; 300	1955	MCW 1955s
Top insulation block: gamma, beta		1; 75	1955	MCW 1955s
Fixing stuck (crucible removal) sleeve: gamma, beta		2; 400	1955	MCW 1955s
General furnace enclosure area: gamma, beta		0.5; 8	1955	MCW 1955s
General furnace enclosure area work: gamma, beta		1; 100	1956	MCW 1956k
Crucible loader (top man), wrist: gamma, beta (mR/day, mrep/day)		0; 90	1956	MCW 1956m
Cleaning furnace enclosure, body at enc armhole: gamma, beta (mR/wk, mrep/wk)		23; 196	1956	MCW 1956n
Cleaning furnace enclosure, body at enclosure armhole: gamma, beta		1; 100	1956	MCW 1956k
Cleaning furnace enclosure, arm: gamma, beta (in mR/week, mrep/week)		23; 488	1956	MCW 1956n
Cleaning furnace enclosure, arm: gamma, beta		1; 300	1956	MCW 1956k
Cleaning furnace enclosure, hand: gamma, beta (in mR/week, mrep/week)		25; 628	1956	MCW 1956n
Cleaning furnace enclosure, hand: gamma, beta		1; 240	1956	MCW 1956k
Vacuum-cleaning burners: gamma, beta		1; 120	1955	MCW 1955s
Setting crucible over to cool: gamma, beta		1; 25	1955	MCW 1955s
Unlidding crucible: gamma, beta		1; 25	1955	MCW 1955s
Removing crucible lid, body: gamma, beta		3; 215	1956	MCW 1956k
Removing crucible lid, arm: gamma, beta (in mR/week, mrep/week)		22; 506	1956	MCW 1956n
Removing crucible lid, arm: gamma, beta		4; 1600	1956	MCW 1956k
Removing crucible lid, hand: gamma, beta (in mR/week, mrep/week)		23; 685	1956	MCW 1956n
Removing crucible lid, hand: gamma, beta		8; 2400	1956	MCW 1956k
Removing crucibles and slugs from enclosure: gamma, beta		2; 400	1955	MCW 1955s

Table 33 (Continued)

	Exposure, % tolerance	Exposure, mrep/hr or mR/hr*	Year	Reference
General burnout area: gamma, beta		1; 8	1955	MCW 1955s
General burnout area work: gamma, beta		0.5; 3	1956	MCW 1956k
Gen'l burnout area work, body at enclo armhole: gamma, beta (mR/wk, mrep/wk)		22; 200	1956	MCW 1956n
Burnout operator, wrist: gamma, beta (mR/day, mrep/day)		90; 215	1956	MCW 1956m
SLAPS (all as "gamma; beta" except where indicated)				
At contact with aged raffinate heaps		0.5-3.3;0.3-0.8	1949	MCW 1949g
Fresh raffinate heap, 1 foot		70; 1.6	1949	MCW 1949g
Fresh raffinate heap, chest height		33; 1.3	1949	MCW 1949g
Fresh raffinate heap, on bulldozer cab pushed into heap		2.7; 1.0	1949	MCW 1949g
"C" material heap, top of pile at waist height		11.5; 1.6	1949	MCW 1949g
"C" material heap, bulldozer cab pushed into heap (ratioed by raff bulldozer result)		7.7; 0.8	1949	MCW 1949g
Aged BC (barium sulfate cake) heap, top of pile at waist height		10; 3-10	1949	MCW 1949g
Aged BC heap bulldozer cab pushed into heap (ratioed by raff bulldozer result)		8.9; 0.13	1949	MCW 1949g
Fresh BC (barium sulfate cake) heap, top of pile at waist height		35; 2.5	1949	MCW 1949g
Fresh BC heap bulldozer cab pushed into heap (ratioed by raff bulldozer result)		2.5; 0.5	1949	MCW 1949g
K-65 storage shed, 2 feet (gamma only)	17.6	2.2	1948	MCW 1950f
K-65 storage shed, 3 feet (gamma only)	12.4	1.6	1948	MCW 1950f
K-65 storage shed, 6 feet (gamma only)	9.0	1.1	1948	MCW 1950f
K-65 storage shed, 9 feet (gamma only)	7.5	0.94	1948	MCW 1950f
K-65 storage shed, 12 feet (gamma only)	6.2	0.78	1948	MCW 1950f
K-65 storage shed, 15 feet (gamma only)	4.3	0.54	1948	MCW 1950f
K-65 storage shed, 18 feet (gamma only)	3.6	0.45	1948	MCW 1950f
K-65 storage shed, 21 feet (gamma only)	2.6	0.33	1948	MCW 1950f
K-65 storage shed, 24 feet (gamma only)	1.8	0.23	1948	MCW 1950f
K-65 storage shed, 27 feet (gamma only)	1.3	0.16	1948	MCW 1950f
K-65 storage shed, 30 feet (gamma only)	0.8	0.10	1948	MCW 1950f
K-65 storage shed, 150 feet (gamma only) -- guard shack location	0.032	0.004	1948	MCW 1950f
PLANT 4, measured beta dose rates analyzed for the design of Plant 6E	**Meter reading, mrep/week**	**Worker film badge avg beta, mrep/wk**	**Year**	**Reference**
Green salt, loading and unloading	816	480	1948	MCW 1948b
Green salt, box pulling	300	415	1948	MCW 1948b
Green salt, milling	432	530	1948	MCW 1948b
Green salt, extra man	300	510	1948	MCW 1948b
Green salt, lead operator	300	360	1948	MCW 1948b
Bomb step, jolting	600	440	1948	MCW 1948b
Bomb step, charging	600	370	1948	MCW 1948b
Bomb step, topping	600	380	1948	MCW 1948b
Bomb step, furnace tender	500	380	1948	MCW 1948b
Bomb step, unloading	600	460	1948	MCW 1948b
Bomb step, chipping	1900	845	1948	MCW 1948b
Bomb step, lime mixing	---	415	1948	MCW 1948b
Bomb step, magnesium mixing	---	300	1948	MCW 1948b
Recasting, furnace tending	500	665	1948	MCW 1948b
Recasting, top furnace tending	2125	1220	1948	MCW 1948b
Recasting, bottom furnace tending	1050	800	1948	MCW 1948b
Recasting, sawing	>500	535	1948	MCW 1948b
Recasting, weighing and packing	613	580	1948	MCW 1948b
PLANT 6, gamma dose rates at area film badge monitoring locations	**Meter reading, mR/hr**	**Average, mR/hr**	**Year**	**Reference**
Digest area: upper platform	2.5	3.8	1955	MCW 1955c
Digest area: lower platform	3	5	1955	MCW 1955c
Cell: lower C-3 area (M-14, M-203); upper C-3 area (Olivers); leach area (Olivers)	2.5; 10; 3	2.6; 14.2; 3.1	1955	MCW 1955c
C-3: lower platform at M-214; upper platform	2; 2	3.8; 2.4	1955	MCW 1955c
Centrifuge area	2	3.4	1955	MCW 1955c
Feinc area: lower platform; upper platform; east area	2; 2; 4.5	3.1; 2.0; 6.5	1955	MCW 1955c
Cell: Feinc Niagara area	1.5	1.7	1955	MCW 1955c

Table 33 (Continued).

* The mrep/hr should be assumed for mixed beta-gamma or for beta alone; the mR/hr should be assumed for gamma only (i.e., either when stated explicitly or when it can be assumed, such as from the side of a tank or bottle). Slashes indicate multiple values. ND means not detectable.

Many figures are given in units of per cent of tolerance, defined in MCW (1949f) as "the amount of exposure that a person can receive 8 hrs/day for an indefinite period of time", presumably corresponding to 100 mR per eight-hour day for gammas and 500 mrep per eight-hour day for betas at the relevant time period. The exposure rates in mR/hr or in mrep/hr were in most cases converted from the original units of R per 8 hours. MED (1945b) gave beta exposure rate figures in "beta units", which as MED (1945c) explained, were the same as "T units", with a T unit being 0.25 "r/hr" of beta radiation. This unit was taken to be 0.25 rep in the table above.

Parentheses indicate the number of measurements, if more than one, used to form the average reported.
Data from AEC 1949f were taken at waist height except where indicated.

Table 34. Neutron dose rates and doses from the alpha-neutron reaction sources and from a RaBe source.

Alpha-neutron source information and dose rates						
Form	**Source**	**Target element(s)**	**Weight in container**	**Dose rate at 1 foot, rem/hr**	**Dose rate at 3 feet, rem/hr**	**Annual dose, rem**
U_3O_8	U natural mix	O	100 lbs	1.29E-07	1.44E-08	4.31E-05
	U natural mix + daughters	O	100 lbs	1.10E-06	1.22E-07	3.67E-04
UO_3, UO_2	U natural mix	O	75 lbs	9.71E-08	1.08E-08	3.24E-05
	U natural mix + daughters	O	75 lbs	8.27E-07	9.19E-08	2.76E-04
UF_4	U natural mix	F	75 lbs	6.92E-06	7.69E-07	2.31E-03
	U natural mix + daughters	F	75 lbs	5.91E-05	6.57E-06	1.97E-02
$Na_2U_2O_7$ (soda salt)	U natural mix	O, Na	75 lbs	2.61E-07	2.90E-08	8.70E-05
	U natural mix + daughters	O, Na	75 lbs	2.13E-06	2.37E-07	7.11E-04
ThF_4	Th-230/Th232 mix	F	198 g	4.08E-04	4.53E-05	1.36E-01
	Th-230/Th-232 mix + daughters	F	198 g	8.97E-04	9.96E-05	2.99E-01
$Th(NO_3)_4$	Th-230/Th232 mix	O	309 g	4.74E-06	5.26E-07	1.58E-03
	Th-230/Th-232 mix + daughters	O	309 g	1.04E-05	1.16E-06	3.47E-03
RaBe source information and dose rates						
RaBe	Ra-226	---	100 mg Ra	1.60E-02	1.77E-03	4.44E+00

Annual organ doses (based on ThF_4 for the alpha-neutron case; Ra-226 for the RaBe case)		
Organ	Alpha-neutron dose, rem	RaBe dose, rem
Bladder	2.09E-01	5.00E+00
Bone marrow	1.16E-01	3.37E+00
Bone surface	1.34E-01	3.15E+00
Breast	3.10E-01	5.08E+00
Colon	1.34E-01	4.17E+00
Esophagus	1.17E-01	4.02E+00
Lung	1.62E-01	4.32E+00
Gonads (ovaries)	1.19E-01	4.15E+00
Gonads (testes)	3.39E-01	5.50E+00
Liver	1.78E-01	4.54E+00
Remainder organs	2.57E-01	4.13E+00
Skin	9.64E-09	4.33E+00
Stomach	2.20E-01	4.96E+00
Thyroid	2.95E-01	5.15E+00

Data used to calculate the alpha-neutron dose rates (except for the assumed amount of U, Th, or Ra material) is from Shleien (1992), Tables 8.4.1, 7.3, and 7.2; Salmon and Hermann (1993), Table 3; DOE (2001a), Table 6-5; Foderaro (1978); and Mlekodaj (2002). Data used to calculate the RaBe dose rates is from Shleien (1992), Tables 7.5 and 8.4.1, and Foderaro (1978). In both cases, the dose conversion factors were taken from NIOSH (2002a). The quantities listed correspond to one drum of material for the uranium forms; to one day's processing for the thorium forms (on a 70-day basis); and to the known RaBe source for the Ra form.

In the alpha-neutron case, the neutron energy was taken as 1.5 MeV because it is the approximate maximum energy for Th-232, the other isotopes also emit neutrons in the range 1.0-2.0, and the flux-to-dose conversion factor varies slowly in this range. For the annual dose, it was assumed that 1 hour /day was spent at 1 foot from the container and three hours/day spent at 3 feet, every working day for a year. In the RaBe case, the neutron energy was taken as 4.0 MeV and it was assumed that 1 hour/day was spent at 1 foot from the unshielded source and 1 hour/day spent at 3 feet, every working day for a year. (This is conservative since the source was likely to be at least partially shielded when in use and completely shielded when not in use.)

In both cases, the maximum organ dose was based on the maximum annual whole-body dose taken to be the ambient dose. For the alpha-neutron source case, an exposure geometry of 75% AP/25% ROT was assumed, as per Table 18 (for "ionium plant operator"); for the RaBe case, 90% AP/10% ROT was assumed, as per Table 18 (for "Shorgun Lab analyst").

Table 35. External gamma dose rates from processing AM-7 residue to concentrate thorium.

Isotope	Gam energy, MeV	Freq	Ci	DR@1 ft, /hr	Annual Dose, R
Th-230	0.142	0.0007	24.4	2.08E-04	6.93E-02
Th-230	0.143	0.00045	24.4	1.35E-04	4.49E-02
Th-232	0.126	0.0004	0.001	4.32E-09	1.44E-06
Ra-226	0.186	0.0328	0.158	8.26E-05	2.75E-02
Total	---	---	48.959	4.25E-04	1.42E-01
	Ratio, Ra/Th	---	3.24E-03	2.41E-01	2.41E-01
	Ratio, Ra/Total	---	3.23E-03	1.94E-01	1.94E-01

Note: Assumptions for the annual dose are as for Table 34, i.e., 1 hours per day were spent at one foot from the unshielded source and 3 hours per day at 3 ft for 250 working days.

Table 36. Weekly external dose values, April 1942–December 1945.

Lognormally distributed doses, rem			
Median weekly photon dose	GSD	Median weekly electron dose	GSD
0.1	1.85	0.124	1.79

Table 37. Monitoring experience from the decontamination/demolition period, 1960-1961 (MCW 1961b).

General outside air concentration during decontamination and demolition

Date sampled	Airborne activity, in units of 10^{-13} uCi/cc		No. samples
	Uranium	Gross alpha	
Dec 1960	4.0	6.8	16
Jan 1961	7.4	6.5	48
Feb 1961	1.1	1.6	104
Mar 1961	1.4	1.7	141
Apr 1961	2.0	6.9	115
May 1961	2.0	4.0	97
Jun 1961	3.3	5.6	69
Jul 1961	1.6	2.8	48
Aug 1961	1.9	4.1	77
Sep 1961	2.2	2.9	83
Oct 1961	3.8	5.0	77
Nov 1961	12.0	6.7	21
Weighted average	2.6	4.0	---

Operational area air concentrations, as airborne alpha activity in uCi/cc

Operation or Area	Average	High
Cutting and removing iron structures, equipment	8.7 E-11	7.7 E-10
Loading iron, equipment by hand and by lift	8.7 E-11	5.3 E-10
Demolishing wood, concrete, or masonry	2.7 E-11	9.2 E-11
Mechanically loading debris and rubble	1.8 E-11	1.1 E-10
Removing tar and gravel roofs	2.5 E-11	1.5 E-11
Dry-sandblasting the insides of buildings	3.6 E-10	7.4 E-10
General area outside bldgs during inside sandblasting	2.7 E-11	9.5 E-11
Dry-sandblasting outside surfaces	4.2 E-11	1.1 E-10
Shoveling residues into small quarters	2.4 E-10	---
Jackhammering Gunite from tanks	8.2 E-10	1.8 E-09
Outside hood during removal of Gunite inside hood	3.4 E-12	---
Cleaning sand, residues from inside vessel after sandblasting	6.4 E-11	---
Steam cleaning of nonsalvageable materials	2.0 E-12	---
Source sampling with wire brush inside pipe after solvent soaking	8.8 E-10	---
Stack exhaust area, from dust collector-hood setup	3.3 E-11	---
General air in building during period of inactivity	1.4 E-11	---

Concentrations of uranium in urine, in mg/L

Sample type		Average	Range
Equipment removal phase	Pre-exposure sample	0.007	0.002 - 0.013
	Monday before work sample	0.010	0.005 - 0.008
	Friday after work sample	0.025	0.003 - 0.078
Decontamination and demolition	Pre-exposure sample	0.005	0.001 - 0.014
	Monday before work sample	0.019	0.003 - 0.058
	Friday after work sample	0.036	0.006 - 0.271
	Termination sample	0.017	0.006 - 0.027
Special operations	Sandblasting	0.031	0.007 - 0.080
	Torch-cutting stainless steel	0.032	---
	Cutting, wrecking a rod mill	0.098	0.061 - 0.135
	Dismantling vacuum, dust collector	0.065	---
	Stripping wiring, metal from bldgs	0.045	0.007 - 0.158

Film badge data

User	Gamma			Beta	
	Annual average, rem	**Highest quarterly reading, rem**	**Highest monthly reading, rem**	**Annual average, rem**	**Highest monthly reading, rem**
Contractor	0.04	0.15	0.08	0.3	0.29
AEC	0.1	---	---	0.6	---
MCW	0.2	---	---	0.8	---
AEC/MCW	---	---	0.14	---	0.15
Visitor	---	---	0.05	---	---

Table 38. Summary of post-decontamination years exposure data as measured by two survey groups.

Plant	Bldg Remaining	1981 Radon daughters, WL	1986 Radon Yearly Avg, WLM/yr	1990 Radon Yearly Avg, WLM/yr		Overall averages, 1981 Source	BG	Average measured levels at St. Louis Site
1	K1E	0.009-0.02	0.05	0.12		Radon in air	<1 pCi/L	0.4 – 37 pCi/L, avg daytime; 69 pCi/L max
	25-1	0.001		0.01		Radon daughters in air	<0.01 WL	0.0009-0.07 WL, avg daytime concentration
	25-2	0.0009		0.01		Gamma from Ra, U daughters	8 µR/hr	8-290 µR /yr @ 1 m above floor
	38							
	40							
2	50	0.0003						
	51	0.0005	0.02	0.01				
	51A		0.02	0.01				
	52A	0.07						
	52	0.0007-0.001		0.00				
6	100			0.02				
	101		0.10	0.01				
6E	116-1		0.00	0.04				
	116-2			0.00				
	116B			0.01				
	117-1			0.00				
	117-2			0.00				
7	700			0.00				
	704		0.03	0.00				
	705			0.00				
	706			0.00				
	708			0.01				

Measurements are from ORNL (1981) and Applied Nuclear Safety (1986; 1990).

Table 39. Measured data used to produce source terms for decontamination and post-decontamination exposure calculations.

			Internal exposure		External exposure			
Plant	Case	Dose potential	Surface alpha, dpm/100 cm^2	Volume alpha, pCi/g	Maximum average gamma, mR/hr	Typical average gamma, mR/hr	Maximum average beta, mrep/hr	Typical average beta, mrep/hr
4	Decon	Low	4.4E+03	1.0E+04	8.0E-02	2.4E-02	1.3E+01	7.5E+00
		Moderate	8.3E+03	4.2E+04	3.0E-01	9.0E-02	2.4E+01	1.4E+01
		High	1.7E+04	8.1E+04	2.0E+00	6.0E-01	4.7E+01	2.7E+01
6	Decon	Low	1.2E+02	1.0E+01	1.0E-01	1.2E-02	1.0E+00	1.2E-01
		Moderate	3.9E+03	7.7E+02	2.5E-01	2.9E-02	2.0E+00	2.4E-01
		High	6.0E+04	3.0E+03	3.0E+00	1.7E+00	3.9E+01	4.6E+00
6E	Decon	Low	4.0E+02	0.0E00	1.0E-01	5.0E-02	2.0E-01	4.3E-02
		Moderate	2.7E+03	3.8E+02	5.0E-01	1.0E-01	1.3E+00	2.8E-01
		High	3.5E+04	1.6E+03	1.4E+00	5.0E-01	1.2E+01	2.5E+00
7	Decon	Low	8.5E+01	0.0E+00	5.0E-02	2.0E-02	1.0E-01	1.7E-02
		Moderate	2.8E+03	1.9E+02	1.0E-01	4.0E-02	1.7E+00	2.9E-01
		High	1.2E+05	2.6E+02	2.5E-01	1.0E-01	1.8E+01	3.0E+00
1	Post-decon	---	---	---	8.7E-02	2.1E-02	8.9E+00	9.0E-01
2	Post-decon	---	---	---	2.1E-02	1.0E-02	9.7E+00	2.3E-01
6E	Post-decon	Low	1.2E+03	0.0E+00	5.4E-02	1.7E-02	5.0E-01	1.0E-01
		Moderate	3.0E+03	3.8E+02	8.1E-02	4.2E-02	7.5E-01	2.5E-01
		High	4.5E+03	1.6E+03	1.6E-01	8.3E-02	1.5E+00	5.0E-01
7	Post-decon	Low	1.0E+03	0.0E+00	8.1E-03	3.2E-03	2.5E-01	1.0E-01
		Moderate	2.8E+03	1.9E+02	1.6E-02	8.1E-03	5.0E-01	2.5E-01
		High	7.5E+03	2.6E+02	3.2E-02	1.6E-02	1.0E+00	5.0E-01

The data in this table was extracted from MCW (1958), MCW(1959), MCW (1961a), and ORNL (1981).

For the Plants 6E and 7 post-decontamination dose rates, the beta/gamma ratio was assumed to be the same as for the corresponding decontamination maximum case. For both decontamination and post-decontamination cases, the High maximum was taken as the maximum average or representative maximum for the respective plant; the High typical value was the average of the non-zero average levels, hence is conservative. Similarly, the Moderate maximum and the Low maximum were the respective middling and low averages. The Moderate and Low typical values were ratioed from the High typical values.

For the Plants 1 and 2 case, the maximum averages were derived from the highest representative measurements in each building and the maximum building in each plant was chosen to be representative of all buildings in that plant. Also for Plants 1 and 2, the measured beta-gamma dose rate was assumed to be all beta, for conservatism and in default of other information; the gamma measurements are based on true gamma-only readings taken with a different instrument than was used to measure the beta-gamma level. The beta-gamma measurements were taken at less than 1 inch (the MCW references) or at 1 cm (ORNL 1981), while the gamma measurements were generally at 3 feet (1 m).

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Table 40. Annual internal exposures during the decontamination and post-decontamination periods.

Decontamination		**Annual average exposure, 1959-1961**			
		Plant 4	**Plant 6**	**Plant 6E**	**Plant 7**
Inhalation, pCi	Low	8.39E+02	1.98E+01	6.86E+01	1.46E+01
	Moderate	1.77E+03	6.67E+02	4.66E+02	4.82E+02
	High	3.48E+03	1.03E+04	6.02E+03	1.97E+04
Radon, WLM	Low	1.43E-02	3.73E-04	1.30E-03	2.76E-04
	Moderate	2.69E-02	1.25E-02	8.76E-03	9.09E-03
	High	5.36E-02	1.95E-01	1.14E-01	3.73E-01
Ingestion, pCi	Low	1.75E+01	4.13E-01	1.43E+00	3.04E-01
	Moderate	3.68E+01	1.39E+01	9.72E+00	1.00E+01
	High	7.25E+01	2.15E+02	1.25E+02	4.11E+02

Post-decontamination	**Annual average exposure, 1962-1995 (1959-1995 for Plants 1 and 2)**							
	Plant 1				**Plant 2**			
	1959-1965	1966-1975	1976-1985	1986-1995	1959-1965	1966-1975	1976-1985	1986-1995
Inhalation, pCi	3.77E+01	3.78E+01	3.80E+01	3.77E+01	3.77E+01	3.78E+01	3.80E+01	3.77E+01
Radon, WLM	4.25E-01	4.17E-01	4.04E-01	3.92E-01	1.42E+00	1.39E+00	1.35E+00	1.31E+00
Ingestion, pCI	7.84E-01	7.87E-01	7.92E-01	7.85E-01	7.84E-01	7.87E-01	7.92E-01	7.85E-01

Post-decontamination		**Plant 6E**				**Plant 7**			
		1959-1965	**1966-1975**	**1976-1985**	**1986-1995**	**1959-1965**	**1966-1975**	**1976-1985**	**1986-1995**
Inhalation, pCi	Low	9.12E+00	5.72E+00	5.75E+00	5.70E+00	4.75E+00	4.77E+00	4.79E+00	4.75E+00
	Moderate	1.71E+01	1.72E+01	1.73E+01	1.72E+01	1.47E+01	1.48E+01	1.49E+01	1.48E+01
	High	3.35E+01	3.36E+01	3.37E+01	3.36E+01	3.76E+01	3.77E+01	3.79E+01	3.76E+01
Radon, WLM	Low	4.54E-03	4.45E-03	4.31E-03	4.18E-03	3.78E-03	3.71E-03	3.60E-03	3.48E-03
	Moderate	1.13E-02	1.11E-02	1.08E-02	1.04E-02	1.06E-02	1.04E-02	1.01E-02	9.75E-03
	High	1.70E-02	1.67E-02	1.62E-02	1.57E-02	2.84E-02	2.78E-02	2.70E-02	2.61E-02
Ingestion, pCi	Low	1.90E-01	1.19E-01	1.20E-01	1.19E-01	9.90E-02	9.93E-02	9.99E-02	9.90E-02
	Moderate	3.57E-01	3.58E-01	3.60E-01	3.57E-01	3.07E-01	3.08E-01	3.10E-01	3.07E-01
	High	6.97E-01	6.99E-01	7.03E-01	7.00E-01	7.83E-01	7.86E-01	7.90E-01	7.84E-01

Inhalation and radon data in this table was calculated with the RESRAD-BUILD computer code (ANL 2003), using measured data from MCW (1958; 1959; 1961a). Both surface contamination and bulk floor and wall contamination were taken into account in calculating the inhalation and radon contributions. Ingestion data were calculated using the ingestion model of OCAS (2004).

"High" exposure potential represents those working in the most contaminated areas, i.e., the former process areas; "Moderate", those accessing less contaminated areas or infrequently accessing former process areas; and "Low", those accessing uncontaminated areas. Plants 1 and 2 did not have enough data for these classifications to be applied.

The Plants 1 and 2 inhalation and ingestion figures were taken to be the same as the Plant 7 figures since the post-D&D contamination figures as given in ORNL (1981) for them were similar to the data for Plant 7. ORNL (1981) showed that while most radon daughter readings were similar in all of the plants, there was one significantly higher reading in both Plant 1 and Plant 2. Thus the Plants 1 and 2 readings are the Plant 7 readings multiplied by the factor of difference for the respective buildings (15 for Plant 1 and 50 for Plant 2). This should be quite conservative since the measured Plant 1 and 2 readings were maxima.

Table 41. Annual external photon organ doses, decontamination and post-decontamination periods (rem per year).

Decontamination years (1959-1961)													
		Plant 4			**Plant 6**			**Plant 6E**			**Plant 7**		
Organ	**Type**	**Low**	**Moderate**	**High**	**Low**	**Moderate**	**High**	**Low**	**Moderate**	**High**	**Low**	**Moderate**	**High**
Bladder	Min	5.6E-02	2.1E-01	1.4E+00	4.9E-02	1.2E-01	3.0E+00	9.2E-02	2.9E-01	1.1E+00	4.0E-02	8.1E-02	2.0E-01
	Mode	1.1E-01	4.1E-01	2.7E+00	9.7E-02	2.4E-01	5.8E+00	1.8E-01	5.7E-01	2.1E+00	7.9E-02	1.6E-01	4.0E-01
	Max	2.9E-01	1.1E+00	7.2E+00	2.5E-01	6.4E-01	1.5E+01	4.7E-01	1.5E+00	5.5E+00	2.1E-01	4.2E-01	1.0E+00
Bone (red marrow)	Min	3.8E-02	1.4E-01	9.5E-01	3.4E-02	8.4E-02	2.0E+00	6.2E-02	2.0E-01	7.2E-01	2.7E-02	5.5E-02	1.4E-01
	Mode	7.4E-02	2.8E-01	1.9E+00	6.6E-02	1.6E-01	4.0E+00	1.2E-01	3.9E-01	1.4E+00	5.4E-02	1.1E-01	2.7E-01
	Max	2.0E-01	7.3E-01	4.9E+00	1.7E-01	4.3E-01	1.0E+01	3.2E-01	1.0E+00	3.7E+00	1.4E-01	2.8E-01	7.1E-01
Bone (surface)	Min	6.7E-02	2.5E-01	1.7E+00	6.0E-02	1.5E-01	3.6E+00	1.1E-01	3.5E-01	1.3E+00	4.9E-02	9.7E-02	2.4E-01
	Mode	1.3E-01	4.9E-01	3.3E+00	1.2E-01	2.9E-01	7.0E+00	2.2E-01	6.9E-01	2.5E+00	9.5E-02	1.9E-01	4.8E-01
	Max	3.5E-01	1.3E+00	8.6E+00	3.1E-01	7.7E-01	1.8E+01	5.7E-01	1.8E+00	6.6E+00	2.5E-01	5.0E-01	1.3E+00
Breast (female)	Min	5.9E-02	2.2E-01	1.5E+00	5.2E-02	1.3E-01	3.1E+00	9.7E-02	3.1E-01	1.1E+00	4.3E-02	8.5E-02	2.1E-01
	Mode	1.2E-01	4.3E-01	2.9E+00	1.0E-01	2.6E-01	6.1E+00	1.9E-01	6.1E-01	2.2E+00	8.3E-02	1.7E-01	4.2E-01
	Max	3.0E-01	1.1E+00	7.6E+00	2.7E-01	6.7E-01	1.6E+01	5.0E-01	1.6E+00	5.8E+00	2.2E-01	4.4E-01	1.1E+00
Colon	Min	5.0E-02	1.9E-01	1.3E+00	4.5E-02	1.1E-01	2.7E+00	8.3E-02	2.7E-01	9.6E-01	3.6E-02	7.3E-02	1.8E-01
	Mode	9.9E-02	3.7E-01	2.5E+00	8.7E-02	2.2E-01	5.3E+00	1.6E-01	5.2E-01	1.9E+00	7.1E-02	1.4E-01	3.6E-01
	Max	2.6E-01	9.7E-01	6.5E+00	2.3E-01	5.7E-01	1.4E+01	4.3E-01	1.4E+00	4.9E+00	1.9E-01	3.7E-01	9.4E-01
Esophagus	Min	3.9E-02	1.5E-01	9.8E-01	3.5E-02	8.7E-02	2.1E+00	6.4E-02	2.1E-01	7.5E-01	2.8E-02	5.7E-02	1.4E-01
	Mode	7.7E-02	2.9E-01	1.9E+00	6.8E-02	1.7E-01	4.1E+00	1.3E-01	4.0E-01	1.5E+00	5.5E-02	1.1E-01	2.8E-01
	Max	2.0E-01	7.5E-01	5.0E+00	1.8E-01	4.5E-01	1.1E+01	3.3E-01	1.1E+00	3.8E+00	1.5E-01	2.9E-01	7.3E-01
Eye	Min	6.0E-02	2.3E-01	1.5E+00	5.3E-02	1.3E-01	3.2E+00	9.9E-02	3.2E-01	1.1E+00	4.4E-02	8.7E-02	2.2E-01
	Mode	1.2E-01	4.4E-01	2.9E+00	1.0E-01	2.6E-01	6.3E+00	1.9E-01	6.2E-01	2.3E+00	8.5E-02	1.7E-01	4.3E-01
	Max	3.1E-01	1.2E+00	7.7E+00	2.7E-01	6.9E-01	1.7E+01	5.1E-01	1.6E+00	5.9E+00	2.2E-01	4.5E-01	1.1E+00
Gonads (ovaries)	Min	4.8E-02	1.8E-01	1.2E+00	4.2E-02	1.1E-01	2.5E+00	7.9E-02	2.5E-01	9.1E-01	3.5E-02	6.9E-02	1.7E-01
	Mode	9.4E-02	3.5E-01	2.3E+00	8.3E-02	2.1E-01	5.0E+00	1.5E-01	4.9E-01	1.8E+00	6.8E-02	1.4E-01	3.4E-01
	Max	2.5E-01	9.2E-01	6.1E+00	2.2E-01	5.4E-01	1.3E+01	4.0E-01	1.3E+00	4.7E+00	1.8E-01	3.6E-01	8.9E-01
Gonads (testes)	Min	6.3E-02	2.3E-01	1.6E+00	5.5E-02	1.4E-01	3.3E+00	1.0E-01	3.3E-01	1.2E+00	4.5E-02	9.1E-02	2.3E-01
	Mode	1.2E-01	4.6E-01	3.1E+00	1.1E-01	2.7E-01	6.5E+00	2.0E-01	6.5E-01	2.3E+00	8.9E-02	1.8E-01	4.4E-01
	Max	3.2E-01	1.2E+00	8.0E+00	2.9E-01	7.1E-01	1.7E+01	5.3E-01	1.7E+00	6.1E+00	2.3E-01	4.7E-01	1.2E+00
Liver	Min	5.2E-02	1.9E-01	1.3E+00	4.6E-02	1.1E-01	2.8E+00	8.5E-02	2.7E-01	9.9E-01	3.7E-02	7.5E-02	1.9E-01
	Mode	1.0E-01	3.8E-01	2.5E+00	9.0E-02	2.2E-01	5.4E+00	1.7E-01	5.3E-01	1.9E+00	7.3E-02	1.5E-01	3.7E-01
	Max	2.7E-01	1.0E+00	6.6E+00	2.4E-01	5.9E-01	1.4E+01	4.4E-01	1.4E+00	5.1E+00	1.9E-01	3.8E-01	9.6E-01
Lung	Min	5.1E-02	1.9E-01	1.3E+00	4.5E-02	1.1E-01	2.7E+00	8.4E-02	2.7E-01	9.7E-01	3.7E-02	7.4E-02	1.8E-01
	Mode	1.0E-01	3.8E-01	2.5E+00	8.9E-02	2.2E-01	5.3E+00	1.6E-01	5.3E-01	1.9E+00	7.2E-02	1.4E-01	3.6E-01
	Max	2.6E-01	9.8E-01	6.6E+00	2.3E-01	5.8E-01	1.4E+01	4.3E-01	1.4E+00	5.0E+00	1.9E-01	3.8E-01	9.5E-01
Remainder organs	Min	4.6E-02	1.7E-01	1.1E+00	4.1E-02	1.0E-01	2.4E+00	7.5E-02	2.4E-01	8.7E-01	3.3E-02	6.6E-02	1.7E-01
	Mode	9.0E-02	3.4E-01	2.2E+00	7.9E-02	2.0E-01	4.8E+00	1.5E-01	4.7E-01	1.7E+00	6.5E-02	1.3E-01	3.2E-01
	Max	2.4E-01	8.8E-01	5.9E+00	2.1E-01	5.2E-01	1.3E+01	3.9E-01	1.2E+00	4.5E+00	1.7E-01	3.4E-01	8.5E-01
Skin	Min	4.9E-02	1.8E-01	1.2E+00	4.3E-02	1.1E-01	2.6E+00	8.0E-02	2.6E-01	9.3E-01	3.5E-02	7.1E-02	1.8E-01
	Mode	9.6E-02	3.6E-01	2.4E+00	8.5E-02	2.1E-01	5.1E+00	1.6E-01	5.0E-01	1.8E+00	6.9E-02	1.4E-01	3.5E-01
	Max	2.5E-01	9.4E-01	6.3E+00	2.2E-01	5.6E-01	1.3E+01	4.1E-01	1.3E+00	4.8E+00	1.8E-01	3.6E-01	9.1E-01
Stomach	Min	5.7E-02	2.1E-01	1.4E+00	5.1E-02	1.3E-01	3.0E+00	9.4E-02	3.0E-01	1.1E+00	4.1E-02	8.3E-02	2.1E-01
	Mode	1.1E-01	4.2E-01	2.8E+00	9.9E-02	2.5E-01	6.0E+00	1.8E-01	5.9E-01	2.1E+00	8.1E-02	1.6E-01	4.0E-01
	Max	2.9E-01	1.1E+00	7.3E+00	2.6E-01	6.5E-01	1.6E+01	4.8E-01	1.5E+00	5.6E+00	2.1E-01	4.2E-01	1.1E+00
Thymus	Min	6.2E-02	2.3E-01	1.6E+00	5.5E-02	1.4E-01	3.3E+00	1.0E-01	3.3E-01	1.2E+00	4.5E-02	9.0E-02	2.2E-01
	Mode	1.2E-01	4.6E-01	3.0E+00	1.1E-01	2.7E-01	6.5E+00	2.0E-01	6.4E-01	2.3E+00	8.8E-02	1.8E-01	4.4E-01
	Max	3.2E-01	1.2E+00	8.0E+00	2.8E-01	7.1E-01	1.7E+01	5.2E-01	1.7E+00	6.1E+00	2.3E-01	4.6E-01	1.2E+00
Thyroid	Min	6.9E-02	2.6E-01	1.7E+00	6.1E-02	1.5E-01	3.7E+00	1.1E-01	3.7E-01	1.3E+00	5.0E-02	1.0E-01	2.5E-01
	Mode	1.4E-01	5.1E-01	3.4E+00	1.2E-01	3.0E-01	7.2E+00	2.2E-01	7.2E-01	2.6E+00	9.8E-02	2.0E-01	4.9E-01
	Max	3.6E-01	1.3E+00	8.9E+00	3.2E-01	7.9E-01	1.9E+01	5.9E-01	1.9E+00	6.8E+00	2.6E-01	5.2E-01	1.3E+00
Uterus	Min	4.8E-02	1.8E-01	1.2E+00	4.2E-02	1.1E-01	2.6E+00	7.9E-02	2.5E-01	9.1E-01	3.5E-02	6.9E-02	1.7E-01
	Mode	9.4E-02	3.5E-01	2.3E+00	8.3E-02	2.1E-01	5.0E+00	1.5E-01	4.9E-01	1.8E+00	6.8E-02	1.4E-01	3.4E-01
	Max	2.5E-01	9.2E-01	6.2E+00	2.2E-01	5.5E-01	1.3E+01	4.1E-01	1.3E+00	4.7E+00	1.8E-01	3.6E-01	8.9E-01
Whole-body dose rate	Min	7.6E-02	2.9E-01	1.9E+00	6.7E-02	1.7E-01	4.1E+00	1.3E-01	4.0E-01	1.5E+00	5.5E-02	1.1E-01	2.8E-01
	Mode	1.5E-01	5.6E-01	3.7E+00	1.3E-01	3.3E-01	7.9E+00	2.4E-01	7.8E-01	2.8E+00	1.1E-01	2.2E-01	5.4E-01
	Max	3.9E-01	1.5E+00	9.8E+00	3.5E-01	8.7E-01	2.1E+01	6.4E-01	2.1E+00	7.5E+00	2.8E-01	5.7E-01	1.4E+00
Post-decontamination years (1962-1995)													
		Plant 1			**Plant 2**			**Plant 6E**			**Plant 7**		
Organ	**Type**	**Low**	**Moderate**	**High**	**Low**	**Moderate**	**High**	**Low**	**Moderate**	**High**	**Low**	**Moderate**	**High**
Bladder	Min	---	---	5.5E-02	---	---	1.9E-02	3.8E-02	7.6E-02	1.5E-01	6.5E-03	1.5E-02	3.0E-02
	Mode	---	---	1.1E-01	---	---	3.7E-02	7.5E-02	1.5E-01	3.0E-01	1.3E-02	2.9E-02	5.8E-02
	Max	---	---	2.8E-01	---	---	9.6E-02	2.0E-01	3.9E-01	7.8E-01	3.3E-02	7.6E-02	1.5E-01
Bone (red marrow)	Min	---	---	3.7E-02	---	---	1.3E-02	2.6E-02	5.1E-02	1.0E-01	4.4E-03	1.0E-02	2.0E-02
	Mode	---	---	7.3E-02	---	---	2.5E-02	5.1E-02	1.0E-01	2.0E-01	8.7E-03	2.0E-02	3.9E-02
	Max	---	---	1.9E-01	---	---	6.5E-02	1.3E-01	2.6E-01	5.3E-01	2.3E-02	5.2E-02	1.0E-01

Table 41 (Continued)

Post-decontamination years (1962-1995)													
		Plant 1			Plant 2			Plant 6E			Plant 7		
Organ	Type	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
Bone (surface)	Min	---	---	6.6E-02	---	---	2.3E-02	4.6E-02	9.1E-02	1.8E-01	7.8E-03	1.8E-02	3.6E-02
	Mode	---	---	1.3E-01	---	---	4.4E-02	9.0E-02	1.8E-01	3.6E-01	1.5E-02	3.5E-02	7.0E-02
	Max	---	---	3.4E-01	---	---	1.2E-01	2.4E-01	4.7E-01	9.4E-01	4.0E-02	9.2E-02	1.8E-01
Breast (female)	Min	---	---	5.8E-02	---	---	2.0E-02	4.0E-02	8.0E-02	1.6E-01	6.9E-03	1.6E-02	3.1E-02
	Mode	---	---	1.1E-01	---	---	3.9E-02	7.9E-02	1.6E-01	3.1E-01	1.3E-02	3.1E-02	6.1E-02
	Max	---	---	3.0E-01	---	---	1.0E-01	2.1E-01	4.1E-01	8.2E-01	3.5E-02	8.0E-02	1.6E-01
Colon	Min	---	---	5.0E-02	---	---	1.7E-02	3.4E-02	6.8E-02	1.4E-01	5.9E-03	1.3E-02	2.7E-02
	Mode	---	---	9.7E-02	---	---	3.3E-02	6.7E-02	1.3E-01	2.7E-01	1.2E-02	2.6E-02	5.2E-02
	Max	---	---	2.6E-01	---	---	8.7E-02	1.8E-01	3.5E-01	7.0E-01	3.0E-02	6.9E-02	1.4E-01
Esophagus	Min	---	---	3.9E-02	---	---	1.3E-02	2.7E-02	5.3E-02	1.1E-01	4.6E-03	1.0E-02	2.1E-02
	Mode	---	---	7.6E-02	---	---	2.6E-02	5.2E-02	1.0E-01	2.1E-01	8.9E-03	2.0E-02	4.1E-02
	Max	---	---	2.0E-01	---	---	6.7E-02	1.4E-01	2.7E-01	5.4E-01	2.3E-02	5.3E-02	1.1E-01
Eye	Min	---	---	5.9E-02	---	---	2.0E-02	4.1E-02	8.2E-02	1.6E-01	7.0E-03	1.6E-02	3.2E-02
	Mode	---	---	1.2E-01	---	---	4.0E-02	8.1E-02	1.6E-01	3.2E-01	1.4E-02	3.1E-02	6.3E-02
	Max	---	---	3.1E-01	---	---	1.0E-01	2.1E-01	4.2E-01	8.4E-01	3.6E-02	8.2E-02	1.6E-01
Gonads (ovaries)	Min	---	---	4.7E-02	---	---	1.6E-02	3.3E-02	6.5E-02	1.3E-01	5.6E-03	1.3E-02	2.5E-02
	Mode	---	---	9.2E-02	---	---	3.1E-02	6.4E-02	1.3E-01	2.5E-01	1.1E-02	2.5E-02	5.0E-02
	Max	---	---	2.4E-01	---	---	8.2E-02	1.7E-01	3.3E-01	6.7E-01	2.9E-02	6.5E-02	1.3E-01
Gonads (testes)	Min	---	---	6.2E-02	---	---	2.1E-02	4.3E-02	8.5E-02	1.7E-01	7.3E-03	1.7E-02	3.3E-02
	Mode	---	---	1.2E-01	---	---	4.1E-02	8.4E-02	1.7E-01	3.3E-01	1.4E-02	3.3E-02	6.5E-02
	Max	---	---	3.2E-01	---	---	1.1E-01	2.2E-01	4.4E-01	8.7E-01	3.8E-02	8.5E-02	1.7E-01
Liver	Min	---	---	5.1E-02	---	---	1.7E-02	3.5E-02	7.0E-02	1.4E-01	6.0E-03	1.4E-02	2.7E-02
	Mode	---	---	1.0E-01	---	---	3.4E-02	6.9E-02	1.4E-01	2.7E-01	1.2E-02	2.7E-02	5.4E-02
	Max	---	---	2.6E-01	---	---	8.9E-02	1.8E-01	3.6E-01	7.2E-01	3.1E-02	7.1E-02	1.4E-01
Lung	Min	---	---	5.0E-02	---	---	1.7E-02	3.5E-02	6.9E-02	1.4E-01	6.0E-03	1.4E-02	2.7E-02
	Mode	---	---	9.9E-02	---	---	3.4E-02	6.8E-02	1.4E-01	2.7E-01	1.2E-02	2.7E-02	5.3E-02
	Max	---	---	2.6E-01	---	---	8.8E-02	1.8E-01	3.6E-01	7.1E-01	3.1E-02	7.0E-02	1.4E-01
Remainder organs	Min	---	---	4.5E-02	---	---	1.5E-02	3.1E-02	6.2E-02	1.2E-01	5.3E-03	1.2E-02	2.4E-02
	Mode	---	---	8.8E-02	---	---	3.0E-02	6.1E-02	1.2E-01	2.4E-01	1.0E-02	2.4E-02	4.8E-02
	Max	---	---	2.3E-01	---	---	7.9E-02	1.6E-01	3.2E-01	6.4E-01	2.7E-02	6.2E-02	1.2E-01
Skin	Min	---	---	4.8E-02	---	---	1.6E-02	3.3E-02	6.6E-02	1.3E-01	5.7E-03	1.3E-02	2.6E-02
	Mode	---	---	9.4E-02	---	---	3.2E-02	6.5E-02	1.3E-01	2.6E-01	1.1E-02	2.5E-02	5.1E-02
	Max	---	---	2.5E-01	---	---	8.4E-02	1.7E-01	3.4E-01	6.8E-01	2.9E-02	6.7E-02	1.3E-01
Stomach	Min	---	---	5.6E-02	---	---	1.9E-02	3.9E-02	7.7E-02	1.5E-01	6.7E-03	1.5E-02	3.0E-02
	Mode	---	---	1.1E-01	---	---	3.7E-02	7.6E-02	1.5E-01	3.0E-01	1.3E-02	3.0E-02	5.9E-02
	Max	---	---	2.9E-01	---	---	9.8E-02	2.0E-01	4.0E-01	7.9E-01	3.4E-02	7.8E-02	1.6E-01
Thymus	Min	---	---	6.1E-02	---	---	2.1E-02	4.2E-02	8.4E-02	1.7E-01	7.2E-03	1.6E-02	3.3E-02
	Mode	---	---	1.2E-01	---	---	4.1E-02	8.3E-02	1.6E-01	3.3E-01	1.4E-02	3.2E-02	6.4E-02
	Max	---	---	3.1E-01	---	---	1.1E-01	2.2E-01	4.3E-01	8.6E-01	3.7E-02	8.5E-02	1.7E-01
Thyroid	Min	---	---	6.8E-02	---	---	2.3E-02	4.7E-02	9.4E-02	1.9E-01	8.1E-03	1.8E-02	3.7E-02
	Mode	---	---	1.3E-01	---	---	4.6E-02	9.3E-02	1.8E-01	3.7E-01	1.6E-02	3.6E-02	7.2E-02
	Max	---	---	3.5E-01	---	---	1.2E-01	2.4E-01	4.8E-01	9.7E-01	4.2E-02	9.5E-02	1.9E-01
Uterus	Min	---	---	4.7E-02	---	---	1.6E-02	3.3E-02	6.5E-02	1.3E-01	5.6E-03	1.3E-02	2.5E-02
	Mode	---	---	9.3E-02	---	---	3.2E-02	6.4E-02	1.3E-01	2.5E-01	1.1E-02	2.5E-02	5.0E-02
	Max	---	---	2.4E-01	---	---	8.3E-02	1.7E-01	3.3E-01	6.7E-01	2.9E-02	6.5E-02	1.3E-01
Whole-body dose rate	Min	---	---	7.5E-02	---	---	2.6E-02	5.2E-02	1.0E-01	2.1E-01	8.9E-03	2.0E-02	4.0E-02
	Mode	---	---	1.5E-01	---	---	5.0E-02	1.0E-01	2.0E-01	4.0E-01	1.7E-02	3.9E-02	7.9E-02
	Max	---	---	3.9E-01	---	---	1.3E-01	2.7E-01	5.3E-01	1.1E+00	4.6E-02	1.0E-01	2.1E-01

Data in this table was calculated using measured data from MCW (1958; 1959; 1961a) as given in Table 39 above. Both maximum average and typical average dose rates at 1 meter (3 feet) were taken into account in calculating the effective gamma (photon) whole-body exposure rates; it was assumed that a worker spent two hours per day (500 hours per year) in the area of maximum dose rate and six hours per day (1500 hours per year) in the area of typical dose rate. The base gamma annual exposures are shown as the whole-body exposure rates above.

The Min, Mode, and Max values were taken to correspond to the effective dose rates at 1 m, 1 foot (30 cm), and 1 cm from the contaminated surface, as per NIOSH direction.

Organ dose conversion factors for the ambient dose equivalent ($H^*(10)$ to H_T) from NIOSH (2002a) were applied to produce the organ doses from photons. A geometry of 50% AP and 50% ROT was used and it was assumed that 100% of the exposure was due to photons in the 30-250 keV range.

"High" exposure potential represents those working in the most contaminated areas, i.e., the former process areas; "Moderate" represents those accessing the less contaminated areas or infrequently accessing the former process areas; and "Low" represents those accessing the uncontaminated areas. Plants 1 and 2 did not have enough data for these classifications to be applied.

Table 42. Annual external electron organ doses during the decontamination and post-decontamination periods (rem per year).

Decontamination years (1959-1961)													
		Plant 4			**Plant 6**			**Plant 6E**			**Plant 7**		
Organ	**Type**	**Low**	**Moderate**	**High**	**Low**	**Moderate**	**High**	**Low**	**Moderate**	**High**	**Low**	**Moderate**	**High**
Skin	Min	2.0E+00	3.8E+00	7.4E+00	7.8E-02	1.6E-01	3.0E+00	1.9E-02	1.2E-01	1.1E+00	8.7E-03	1.5E-01	1.5E+00
	Mode	3.7E+00	6.8E+00	1.3E+01	1.4E-01	2.8E-01	5.5E+00	3.4E-02	2.2E-01	2.0E+00	1.6E-02	2.7E-01	2.8E+00
	Max	1.8E+01	3.3E+01	6.4E+01	6.8E-01	1.4E+00	2.6E+01	1.6E-01	1.1E+00	9.6E+00	7.6E-02	1.3E+00	1.3E+01
Breast	Min	8.0E-01	1.5E+00	2.9E+00	3.1E-02	6.1E-02	1.2E+00	7.5E-03	4.8E-02	4.3E-01	3.4E-03	5.8E-02	6.0E-01
	Mode	1.4E+00	2.7E+00	5.2E+00	5.5E-02	1.1E-01	2.2E+00	1.3E-02	8.7E-02	7.8E-01	6.2E-03	1.0E-01	1.1E+00
	Max	6.9E+00	1.3E+01	2.5E+01	2.7E-01	5.3E-01	1.0E+01	6.5E-02	4.2E-01	3.7E+00	3.0E-02	5.0E-01	5.2E+00
Testes	Min	3.9E-01	7.2E-01	1.4E+00	1.5E-02	3.0E-02	5.9E-01	3.7E-03	2.4E-02	2.1E-01	1.7E-03	2.9E-02	2.9E-01
	Mode	7.1E-01	1.3E+00	2.6E+00	2.7E-02	5.4E-02	1.1E+00	6.6E-03	4.3E-02	3.8E-01	3.0E-03	5.1E-02	5.3E-01
	Max	3.4E+00	6.3E+00	1.2E+01	1.3E-01	2.6E-01	5.1E+00	3.2E-02	2.1E-01	1.8E+00	1.5E-02	2.5E-01	2.5E+00
Post-decontamination years (1962-1995)													
		Plant 1			**Plant 2**			**Plant 6E**			**Plant 7**		
Organ	**Type**	**Low**	**Moderate**	**High**	**Low**	**Moderate**	**High**	**Low**	**Moderate**	**High**	**Low**	**Moderate**	**High**
Skin	Min	5.3E-02	1.0E-01	6.7E-01	1.4E-02	2.8E-02	6.0E-01	4.6E-02	8.7E-02	1.7E-01	3.2E-02	7.2E-02	1.4E-01
	Mode	9.6E-02	1.9E-01	1.2E+00	2.5E-02	5.0E-02	1.1E+00	8.3E-02	1.6E-01	3.1E-01	5.7E-02	1.3E-01	2.6E-01
	Max	4.6E-01	9.0E-01	5.8E+00	1.2E-01	2.4E-01	5.2E+00	4.0E-01	7.5E-01	1.5E+00	2.8E-01	6.3E-01	1.3E+00
Breast	Min	2.1E-02	4.1E-02	2.6E-01	5.4E-03	1.1E-02	2.4E-01	1.8E-02	3.4E-02	6.8E-02	1.2E-02	2.8E-02	5.7E-02
	Mode	3.7E-02	7.3E-02	4.7E-01	9.8E-03	2.0E-02	4.2E-01	3.3E-02	6.1E-02	1.2E-01	2.2E-02	5.1E-02	1.0E-01
	Max	1.8E-01	3.5E-01	2.3E+00	4.7E-02	9.4E-02	2.0E+00	1.6E-01	2.9E-01	5.9E-01	1.1E-01	2.5E-01	4.9E-01
Testes	Min	1.0E-02	2.0E-02	1.3E-01	2.7E-03	5.3E-03	1.2E-01	8.9E-03	1.7E-02	3.3E-02	6.1E-03	1.4E-02	2.8E-02
	Mode	1.8E-02	3.6E-02	2.3E-01	4.8E-03	9.6E-03	2.1E-01	1.6E-02	3.0E-02	6.0E-02	1.1E-02	2.5E-02	5.0E-02
	Max	8.8E-02	1.7E-01	1.1E+00	2.3E-02	4.6E-02	1.0E+00	7.7E-02	1.4E-01	2.9E-01	5.3E-02	1.2E-01	2.4E-01

Data in this table was calculated using measured data from MCW (1958; 1959; 1961a) as given in Table 39 above. Both maximum average and typical average dose rates at about 1 cm were taken into account in calculating the effective electron (beta) base exposure rates; it was assumed that a worker spent two hours per day (500 hours per year) in the area of maximum dose rate and six hours per day (1500 hours per year) in the area of typical dose rate. The base annual exposures are shown as the skin exposures above.

The Min, Mode, and Max values were taken to correspond to the effective dose rates at 1 cm, 1 foot (30 cm), and 1 meter from the contaminated surface, as per NIOSH direction.

Organ dose conversion factors for conversion from skin dose to breast and testes doses were taken from ICRP (996); these are 0.49 for the breast and 0 .24 for the testes. In addition, a factor of .8 was used to account for clothing coverage for the breast and testes doses.

"High" exposure potential represents those working in the most contaminated areas, i.e., the former process areas; "Moderate" represents those accessing the less contaminated areas or infrequently accessing the former process areas; and "Low" represents those accessing the uncontaminated areas. Plants 1 and 2 did not have enough data for these classifications to be applied.

Table 43. Annual dust inhalation, ingestion, and radon daughter intakes during the SLAPS postoperations period.

	Inhalation intakes, pCi/yr		**Ingestion intakes, pCi/yr**		**Radon intakes, WLM/yr**	
	1959-1960	**1961-1962**	**1959-1960**	**1961-1962**	**1959-1960**	**1961-1962**
Bulldozer/crane operators	8.81E+03	---	1.84E+02	---	4.75E+00	---
Other material workers (e.g., riggers)	8.81E+03	---	1.84E+02	---	4.75E+00	---
Health & Safety workers	4.41E+03	---	9.18E+01	---	2.38E+00	---
AEC	4.41E+03	1.49E-04	9.18E+01	3.10E-06	2.38E+00	2.28E-01
Guards	7.14E+02	1.00E-03	1.49E+01	6.46E-06	1.54E+00	1.54E+00

Table 44. Annual external gamma organ doses during the SLAPS postoperations period (rem per year).

Organ	1959-1960 Bulldozer driver, rigger	1959-1960 Health & Safety, AEC	1959-1960 Guard	1961-1962 Guard
Bladder	1.32E-01	6.60E-02	4.28E-02	1.32E-02
Bone (red marrow)	1.30E-01	6.50E-02	4.21E-02	1.30E-02
Bone (surface)	2.14E-01	1.07E-01	6.92E-02	2.14E-02
Breast (female)	1.47E-01	7.34E-02	4.75E-02	1.47E-02
Colon	1.31E-01	6.53E-02	4.23E-02	1.31E-02
Esophagus	1.27E-01	6.33E-02	4.10E-02	1.27E-02
Eye	1.60E-01	8.00E-02	5.18E-02	1.60E-02
Gonads (ovaries)	1.33E-01	6.65E-02	4.31E-02	1.33E-02
Gonads (testes)	1.39E-01	6.96E-02	4.51E-02	1.39E-02
Liver	1.39E-01	6.95E-02	4.50E-02	1.39E-02
Lung	1.49E-01	7.44E-02	4.82E-02	1.49E-02
Remainder organs	1.34E-01	6.70E-02	4.34E-02	1.34E-02
Skin	1.52E-01	7.60E-02	4.92E-02	1.52E-02
Stomach	1.38E-01	6.89E-02	4.46E-02	1.38E-02
Thymus	1.42E-01	7.10E-02	4.60E-02	1.42E-02
Thyroid	1.84E-01	9.19E-02	5.95E-02	1.84E-02
Uterus	1.24E-01	6.21E-02	4.03E-02	1.24E-02
Measured whole-body dose rate	2.50E-01	1.25E-01	8.10E-02	2.50E-02

APPENDIX A

Notes on How the "Tolerance" or "Preferred" Level for Insoluble Uranium Compounds in Air Was Calculated in 1948

(From AEC 1949b)

Assumptions

1. The "tolerance" alpha radiation level to the lung is 30 mrep/week or 4.3 mrep/day.
2. The fraction of inhaled material retained in the lungs and pulmonary lymphatic tissue is 0.25.
3. The biological half-life of insoluble uranium compounds in the lung is 90 days.
4. The weight of a pair of lungs is 1000 grams.
5. An individual inhales 10 cubic meters per 8-hour working day.

Calculations

1. µCi/g in lung required to deliver 4.3 mrep/day: = $\frac{(5.2 \times 10^7)\ (0.0043)}{2.2 \times 10^6 \times 60 \times 24 \times 8.86}$

   where

5.2×10^7	=	number of MeV/g in one rep
0.0043 rep/day	=	daily acceptable dose rate
2.2×10^6	=	number of dis/min per µCi
60×24	=	number of minutes per day
8.86	=	sum of energies of alpha radiation from U-238 and U-234 in equilibrium, in MeV

   = 8×10^{-6} µCi/g

2. Total µCi in lungs for 4.3 mrep/day:

   = $1000 \times 8 \times 10^{-6}$
   = 8×10^{-3} µCi

3. µCi per 10 m^3 (inhaled in 8 hours) which will give 8×10^{-3} µCi to the lung at equilibrium (assuming exposure every day) = 2.54×10^{-4} µCi per 10 m^3

   where

8×10^{-3}	=	µCi in lungs at equilibrium
0.25	=	fraction of inhaled material deposited in the lung
90	=	assumed biological half-life in the lungs, in days
1.4	=	factor to convert half-life to mean life

4. µCi per m^3:

   = 2.54×10^{-5}
   = 56 dpm per m^3

5. Adjustment for actual exposure occurring up to 6 days a week, when 7 days was assumed:

   56 dpm * (7 days/6 days) = 65 dpm
   (i.e., 5-6 days per week actually, since 56 dpm * (7 days/5 days) = 78 dpm

   and

   = **70 dpm per m^3**
   = **50 µg per m^3**

Note: As AEC 1949b states, these calculations use no factor to account for nonuniform distribution in the lungs. It is also stated that the acceptable weekly dose rate for alpha dust exposures was going to be changed (presumably by AEC) to either 30 mrep/week or 15 mrep/week.

APPENDIX B

Example Calculation of Daily Weighted Average Exposure (DWE)

Calculation for Continuous Experimental Furnace Operators (from MCW 1950s)

Operation	Minutes per event	# events, day shift	# events, night shift	Total time, day shift	Total time, night shift	Measured alpha conc, dpm/m^3	Conc times total time, day shift	Conc times total time, night shift
Filling hopper	1.75	10	10	18	18	131000 (avg of 3) H 153000 L 102000	2,358,000	2,358,000
Removing bottle	3	16	15	48	45	1640 (avg of 3) H 3440 L 265	78,720	73,800
Dumping bottles into drum	3.5	3	3	10	10	181000 (avg of 2) H 236000 L 125000	1,810,000	1,810,000
Sampling the drum	1	3	3	3	3	407 (avg of 3) H 569 L 234	1,221	1,221
General air, furnace area				276	259	238 (avg of 6) H 908 L 8.5	65,688	61,642
General air, sampling area				60	60	175 (avg of 4) H 191 L 131	10,500	10,500
General air, smoking room				50	40	314 (avg of 3) H 378 L 248	15,700	12,560
General air, locker room				15	5	4.2 (avg of 5) H 6.5 L 0.7	63	21
General air, change room				15	15	68 (avg of 5) H 101 L 19	1,020	1,020
General air, lunchroom				30	40	1.27 (avg of 8) H 2.0 L 0.56	38.1	50.8
TOTAL	---	---	---	525	495	---	4,340,950	4,328,815
Average	---	---	---	505		---		

$$\text{Average alpha concentration} = \frac{4340950}{505} = \mathbf{8596}\ \text{dpm/m}^3$$

$$\text{Average “times tolerance” exposure} = \frac{8596}{70} = \mathbf{123}$$

Note: H and L denote the high and low values respectively.